NOTICE

All drawings located at the end of the document.

#000065762

ER/WM&I DDT

Source/Driver (Name & Number from ISP, IAG milestone, Mgmt Action, Corres Control, etc)

Closure # (Outgoing Correspondence Control #, if applicable)

Due Date

A. L. Primrose
Originator Name

G D DiGregorio
QA Approval

J. E Law
Contractor Manager(s)

J Uhland
Kaiser-Hill Program Manager(s)

A D Rodgers
Kaiser-Hill Director

Document Subject

SAMPLING AND ANALYSIS PLAN FOR THE SITE CHARACTERIZATION OF THE 903 DRUM STORAGE AREA (IHSS 112), 903 LIP AREA (IHSS 155), AND AMERICIUM ZONE - JEL- 29-97

KH-00003NS1A December 16, 1997

Discussion and/or Comments

Please find enclosed 7 copies of the Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area (IHSS 112), 903 Lip Area (IHSS 155), and Americium Zone Included are 2 copies for Kaiser-Hill, 3 copies for the DOE, and 2 copies for the CDPHE Three copies were previously delivered on December 15, 1997 to DOE for transmittal to the EPA All Kaiser-Hill and regulatory agency comments have been incorporated into this document

If you have any questions regarding this document, please contact Annette Primrose at extension 4385 or Ty Vess at extension 6540

Attachments
As Stated

cc
A C Crawford
J E Law
S M Paris
A L Primrose
M R Wood
A L Primrose
Administrative Record
[redacted]

ADMIN REC

ER/WM&I DDT

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M R Wood
A L Primrose
Administrative Record
RMRS Records

KAISER•HILL
COMPANY

RMRS Rocky Mountain Remediation Services L.L.C
protecting the environment

SAMPLING AND ANALYSIS PLAN FOR THE SITE CHARACTERIZATION OF THE 903 DRUM STORAGE AREA (IHSS 112), 903 LIP AREA (IHSS 155), AND AMERICIUM ZONE

RF/RMRS-97-084

Environmental Restoration
Rocky Flats Environmental Technology Site

December 15, 1997
Rev. 0

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Rocky Mountain Remediation Services, L.L.C

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RF/RMRS-97-084

Prepared By
Rocky Mountain Remediation Services, L L C
Rocky Flats Environmental Technology Site
Golden, Colorado

December 15, 1997
Revision 0

Project Manager A L Primrose for T Vess Date 12/15/97

Quality Assurance [signature] Date 12/15/97

Radiological Engineering [signature] Date 12/15/97

EXECUTIVE SUMMARY

Radiological contamination of surface soils exceeding Rocky Flats Cleanup Agreement (RFCA) Tier I soil action levels at the 903 Drum Storage Area (903 Pad), 903 Lip Area (Lip Area), and the Americium Zone are known from previous investigations Contamination was a result of releases associated with the historical use of the 903 Pad for outdoor storage of drums containing volatile organic compounds (VOCs) contaminated with plutonium and uranium from 1958 until 1967 The 903 Pad and Lip Area were sources of radiological contamination impacting surface soil VOCs have impacted groundwater as a result of leaking drums

The purpose of this sampling and analysis plan (SAP) is to further refine the volume estimates of radiologically-contaminated surface soils, radiologically-contaminated subsurface soils, and VOC-contaminated soils (i e , above RFCA action levels) for selection of appropriate remedial designs, as well as the asphalt covering the 903 Pad

Characterization of the areal extent of radiologically-contaminated surface soils will utilize *in situ* gamma-ray spectroscopy methodology with tripod-mounted high purity germanium (HPGe) units Tripod-mounted HPGe units have a detector height of one meter Given this orientation, approximately 90 percent (%) of the gamma-rays measured by the detector originate from a circle on the ground whose diameter is approximately 10 to 12 meters (32 to 39 feet) This is often referred to as the detector's field of view (FOV) HPGe measurement results will be correlated to soil sample results collected at the measurement location (i e , FOV)

Investigation decision levels for the HPGe survey are 1) contamination defined by radionuclide concentrations in soils equal to or above RFCA Tier I soil action levels using the sum of ratios equation, and 2) cessation of surveying based on two contiguous HPGe measurement results less than 10 pCi/g americium-241 (^{241}Am) within the investigation boundary limit

The vertical extent of radiological contamination at the 903 Pad, Lip Area, and the Americium Zone will be determined based on previously collected data and if needed by using a statistically based grid to locate shallow soil borings Subsurface soil samples collected at these locations will be analyzed by alpha spectroscopy at a laboratory for isotopic determination Subsurface soil sample results above RFCA Tier I soil action levels will define the vertical extent of radiologically-contaminated soil at the 903 Pad and Lip Area for input into the remediation estimate Boundaries of radiologically-contaminated subsurface soil at the 903 Pad and Lip Area will be refined by "step-out" borings located at half the grid distance between borings with results below Tier I soil action levels and a boring with results above RFCA Tier I soil action levels

Characterization of VOC-contaminated soil will utilize a judgmental sampling strategy with soil borings radially placed upgradient of two VOC-contaminated groundwater wells at the 903 Pad and historical drum storage areas Groundwater data for these wells indicates carbon tetrachloride and tetrachloroethene present at concentrations greater than ten percent of their respective aqueous solubilities A soil boring will also be completed at the soil gas anomaly in the Lip Area, southeast of the 903 Pad Subsurface soil samples will be collected for VOC and radiochemical analyses Additional (step-out) borings will be completed on the basis of analytical results greater than 10 percent of the Tier I subsurface soil action level for VOCs

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LIST OF ACRONYMS

ALF	Action Level Framework
ASD	Analytical Services Division
CDH	Colorado Department of Health
cm	centimeters
cpm	counts per minute
DOE	US Department of Energy
DNAPL	Dense Non-Aqueous Phase Liquid
DQO	Data Quality Objective
EA	Exposure Area
EPA	Environmental Protection Agency
ERM	Environmental Restoration Management
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FO	Field Operations
FOV	Field Of View
ft^2	square feet
GT	Geotechnical
GPS	Global Positioning System
HPGe	High Purity Geranium
IDM	Investigative Derived Material
in	inches
IHSS	Individual Hazardous Substance Site
K-H	Kaiser-Hill
LDR	Land Disposal Restriction
m	meters
mg/kg	milligrams per kilogram
mg/L	milligrams per Liter
NAPL	Non-Aqueous Phase Liquid
OU	Operable Unit
OVM	Organic Vapor Meter
%	percent
pCi/g	Picocuries Per Gram
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PID	Photoionization Detector
QAPD	Quality Assurance Project Description
QA	Quality Assurance
QC	Quality Control
RFI/RI	Resource Conservation and Recovery Act Facilities Investigation/ Remedial Investigation
RFCA	Rocky Flats Cleanup Agreement
RFEDS	Rocky Flats Environmental Database System
RFETS	Rocky Flats Environmental Technology Site
RMRS	Rocky Mountain Remediation Services, L L C
ROD	Record of Decision
ROI	Radiological Operations Instructions

LIST OF ACRONYMS (Cont)

RPD	Relatıve Percent Dıfference
SAP	Samplıng and Analysıs Plan
SOP	Standard Operatıng Procedure
SSOC	Safe Sıtes of Colorado, L L C
ug/L	Mıcrograms per Lıter
ug/Kg	Mıcrograms per Kılogram
VOC	Volatıle Organıc Compound

STANDARD OPERATING PROCEDURES

NUMBER	PROCEDURE TITLE
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4-S02-ENV-OPS-FO 04	Decontamınatıon of Equıpment at Decontamınatıon Facılıtıes
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1-M12-WO4034	Radioactive Waste Packaging Requirements
4-C77-WO-1101	Solid Radioactive Waste Packaging
1-C80-WO-1102-WRT	Waste/Residue Traveler Instructions
PADC-96-00003	WSRIC for OU Operations, Version 6 0, Section No 1

1.0 INTRODUCTION

The purpose of this Sampling and Analysis Plan (SAP) is to estimate the volume of soils exceeding the Rocky Flats Environmental Technology Site (RFETS) Cleanup Agreement (RFCA) Action Level Framework (ALF) Tier I Soil Action Levels or other action levels identified as being protective of surface water for radionuclides and volatile organic compounds (VOCs) at the 903 Drum Storage Area (903 Pad, Individual Hazardous Substance Site [IHSS] 112), the 903 Lip Area (Lip Area, IHSS 155), and the Americium Zone (Figure 1 1) The 903 Pad, Lip Area, and Americium Zone are located in the Buffer Zone Operable Unit (OU) The scope of this SAP also includes the surface soils of OU No 1, 881 Hillside, which have been administratively incorporated into the Buffer Zone OU (DOE, 1995b) The Buffer Zone OU has been designated for restricted open space land use

In 1996 the Actinide Migration Expert Panel was formed to review existing data on actinide migration at RFETS and make recommendations for future work Panel recommendations included developing a conceptual model for actinide transport, based on a thorough understanding of chemical and physical processes, investigating the long-term impacts of actinide geochemical mobility on remedial requirements, and evaluating the protectiveness of the RFCA soil action levels to surface water quality This SAP has incorporated data interpretations from the Actinide Migration Expert Panel presented in the *Summary of Existing Data on Actinide Migration at the Rocky Flats Environmental Technology Site* (DOE, 1997a) Based on modeling currently being performed by the Actinide Migration Expert Panel, revisions to this SAP may be necessary **However, measurement techniques purported in this SAP provide adequate sensitivity to identify soils exceeding much lower soil action levels than those currently stipulated by RFCA, should the Actinide Migration Expert Panel conclude that soil action levels be lowered to protect surface waters.**

The Americium Zone is defined as the general area located outside the 903 Pad and Lip Area within the RFETS boundaries that have been impacted by past waste disposal and/or cleanup activities associated with the 903 Pad and 903 Lip Area The Americium Zone exhibits americium-241(^{241}Am) activities above background levels as defined by the *Geochemical Characterization of Background Surface Soils Background Soils Characterization Program*

(DOE, 1995d) Based on that program, the mean background activity for ^{241}Am for Front Range soils is 0 0107 picocuries per gram (pCi/g)

Implementation of this SAP will provide a more accurate estimate of the volume of soil exceeding Tier I soil action levels for a remedial alternative analysis Tier I soil action levels are numeric levels, that, when exceeded, trigger an evaluation, remedial action or management action (DOE, 1996) Tier I soil action levels for radionuclides are based on the sum of ratios equation (see Section 2 5 1) Existing data suggests that an interim remedial action will be warranted The estimated volume of contaminated soil calculated from data generated by this investigation will be used as input data for a remedial alternative analysis in a future interim measure/interim remedial action (IM/IRA) or Proposed Action Memorandum (PAM)

Investigation decision levels for the HPGe survey are 1) contamination defined by radionuclide concentrations in soils equal to or above RFCA Tier I soil action levels, and 2) cessation of surveying based on two contiguous HPGe measurement results less than 10 pCi/g americium-241 (^{241}Am) within the investigation boundary limit

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1.1 Background

Releases at the 903 Drum Storage Site (IHSS 112) are considered the primary source of radiological contamination in the surficial soil in this part of RFETS Drums that contained radiologically-contaminated oils and VOCs were stored at this location from the summer of 1958 to January 1967 Approximately three fourths of the drums contained plutonium-contaminated liquids while most of the remaining drums contained uranium-contaminated liquids Of the drums containing plutonium, the liquid was primarily lathe coolant and carbon tetrachloride in varying proportions Also stored in the drums were hydraulic oils, vacuum pump oils, trichloroethene, tetrachloroethene (perchloroethylene), silicone oils, and acetone still bottoms (DOE, 1995a)

Leaking drums were noted in 1964 during routine handling operations The contents of the leaking drums were transferred to new drums, and the area was fenced to restrict access When cleanup operations began in 1967, a total of 5,237 drums were at the drum storage site Approximately 420 drums leaked to some degree Of these, an estimated 50 drums leaked their entire contents The total amount of material released was estimated at 5,000 gallons of contaminated liquid containing approximately 86 grams of plutonium (DOE, 1995a)

From 1968 through 1970, some of the radiologically-contaminated material was removed, the surrounding area was graded, and much of the area was covered by an imported base coarse material (artificial fill) and asphalt cap However, during drum removal and cleanup activities, wind and rain spread plutonium-contaminated soils to the east and southeast from the 903 Pad area resulting in IHSS 155 (903 Lip Area) Several limited excavations in 1976, 1978, and 1984 have removed some of the plutonium-contaminated soils from the Lip Area (DOE, 1995a, Barker, 1982, and Setlock, 1984) However, sampling and analysis results from the OU2 Phase II RFI/RI (DOE, 1995a) confirm that radiologically-contaminated soils remain

Surface soils to the east and southeast of the Lip Area also exhibit elevated plutonium-239/240 ($^{239/240}$Pu) and ^{241}Am activities This contamination is primarily attributed to wind dispersion from the 903 Pad with potential contributions from historical fires and stack effluent Areas exhibiting elevated $^{239/240}$Pu and ^{241}Am activities east and southeast of the Lip Area are known as the Americium Zone

In 1989, the Federal Bureau of Investigations sent a "Tiger Team" of investigators to RFETS The Tiger Team reported observing at least two areas where erosion was occurring or had recently occurred and that the eroded material contained elevated readings on hand held radiation detectors The DOE Remote Sensing Laboratory in Las Vegas, Nevada, was contracted to perform fly-over gamma-ray spectrometry surveys of the site, truck and tripod-mounted gamma-ray spectrometry measurements, and traditional soil sampling in an attempt to assess the radiological conditions

It was subsequently recognized that a gamma-ray spectrometry analytical capability was needed at RFETS A team of experts was formed in 1991 by EG&G Rocky Flats, the Site management and operating contractor at that time, for the purpose of assembling and establishing a high purity germanium (HPGe) gamma spectrometry program onsite This team assembled a mobile system using an array of six, 75% relative efficient, N-type HPGe detectors The array was attached to a telescoping mast which could position the detector package from 10 centimeters (cm) to over 6 5 meters (m) above the ground This truck-mounted array was utilized to perform systematic *in situ* measurements at selected areas

1 1 1 Overview of *In Situ* Gamma-ray Spectroscopy

Simply stated, the measurement takes place with the sensor positioned over the area of interest and a gamma-ray energy spectrum is collected over a period of time If there is material between the area to be characterized and the detector such as water/snow, gravel, pavement, concrete, or even clean soil then the measurement becomes more complex Any material between the sensor and the area of interest will reduce the amount of unscattered flux effectively shielding a potential source term

In the past, simple counting systems moved from the laboratory to the field and today there are countless models of 'health physics' instrumentation In 1972 Harold Beck with his colleagues, J DeCampo and C Gogolak at the United States Atomic Energy Commission, Health and Safety Laboratory now called the United States Department of Energy, Environmental Measurements Laboratory, published a paper entitled *In situ Ge(Li) and NaI(Tl) Gamma-Ray Spectrometry,* HASL 258 This document has become the 'bible' to the *in situ* gamma-ray spectroscopist HASL 258 shows that the *in situ* measurement integrates the activity over a large volume and the results can be presented as activity per unit mass averaged over the measured volume The spatial variability of the activity is smoothed and a more representative value for the activity in a given plot of land could be obtained This methodology does not pre-empt the requirement for soil samples but rather enables the investigator to develop a more meaningful sample strategy

In situ gamma-ray spectrometry provides several benefits over other analytical methods Gamma-ray spectrometry measurements allow a rapid return of data (i e , within 24 hours), while producing quantitative estimates of the activities of radioactive isotopes present A larger volume of sample may be analyzed, thereby allowing a more representative determination of the radioactive isotopes present Gamma-ray spectrometry analysis does not require sample dissolution, thus eliminating errors caused by incomplete dissolution and matrix interference *The Compendium of In Situ Radiological Methods and Applications at Rocky Flats Plants* (EG&G, 1993) provides a detailed discussion on the physics of *in situ* measurement of radionuclides in the environment

The technique is currently in use at the DOE's Fernald Site in support of the D&D activities *In situ* gamma-ray spectrometry has been successfully used at DOE's Nevada Test Site to provide source term information for dose calculations It has been used in support of the cleanup of the Marshall Islands as well as the Johnston Atol The method also supported the cleanup of the former sampling plant located at Middlesex, New Jersey In short, the method has supported and is supporting environmental assessment of radionuclides for almost three decades including Rocky Flats

Previous investigations at OUs 1, 2, 9, and 10 utilized *in situ* gamma-ray spectrometry measurements for human health and environmental risk assessments Examples of HPGe investigations include the *881 Hillside Hot Spot Removal Project in OU1* (DOE, 1995c) This project was performed successfully with regulatory approval of the technique

HPGe gamma-ray spectrometry methodology will be used during this investigation for further refining the areal extent of radiologically-contaminated soil for planning remedial alternatives for the Americium Zone and the Lip Area HPGe surveys in a portion of the Lip Area may be omitted in the event the subsurface soil sampling program identifies natural soils (beneath the artificial fill) exceeding Tier I soil action levels in this area

1 1 2 Project Study Area

The project study area for this investigation was selected to include surface and subsurface soils in the primary source area (903 Pad), the secondary source area (Lip Area) and areas impacted downwind of the source (Americium Zone) The study area represents the area in which data were evaluated to determine locations where an exceedance to RFCA Tier I soil action levels may be present This represents an area bounded by Indiana Street to the east, Pond C-2 to the south, Pond B-5 to the north, and Building 886 to the west (excluding areas inside the protected area [PA]) Figure 1 1 shows the extent of the study area

The study area includes locations sampled under three surface soil sampling programs conducted in support of the OU2 RFI/RI (DOE, 1995a) and locations sampled under one surface soil sampling program performed under the OU1 RFI/RI (DOE, 1994a) Subsurface soil analytical results were also obtained from samples collected from boreholes completed for numerous projects including the OU1 and OU2 RFI/RIs Subsurface soil samples were also collected beneath the 903 Pad in support of a soil decontamination feasibility study and from 26 soil profile excavations completed during the OU2 RFI/RI The study area also includes areas identified by data collected from two previous HPGe investigations

1 1 3 Project Investigation Area

Existing data in the study area were compiled and evaluated with respect to the Tier I soil action levels to determine areas suspected to exceed RFCA Tier I soil action levels The Investigation Area represents the area where additional characterization is required to refine the volume estimate of contaminated soils (Figure 1 2) The area requiring additional characterization is hereafter identified as the Investigation Area The Investigation Area represents that portion of the study area which is known, or which a potential exists, for surface and/or subsurface soils to exceed Tier I soil action levels These areas include

- Surface soils exceeding 10 pCi/g ^{241}Am as identified from the 1990 and 1994 HPGe Surveys,
- Areas where artificial fill has been placed over natural soils including the 903 Pad, Lip Area, and areas remediated in 1976, 1978, and 1984,
- Five 2 5-acre plots identified as exceeding Tier I soil action levels based on OU2 RFI/RI surface soil sample results, and
- The 903 Pad and Lip Area where a subsurface VOC source is suspected as the source of a groundwater contaminant plume

1 2 *Existing Data Summary*

Numerous investigations to assess the extent of contamination at the 903 Pad, Lip Area, and Americium Zone have been conducted These investigations are briefly described below

1 2 1 Surface Soils

HPGe Surveys - *In situ* gamma-ray spectrometry surveys (i e , HPGe surveys) were conducted in 1990 (EG&G, 1991) and 1994 (RMRS, 1996) using the truck-mounted array to generate data on the activity of ^{241}Am in surface soils in the Americium Zone Data was collected from a grid consisting of a 45 7 m (150 ft) diameter circle for the truck mounted array's FOV of 1,642 m^2 (17,671ft^2 or 0 4 acre) HPGe surveys were not conducted over the 903 Pad and the eastern portion of the 903 Lip Area Surface soil samples were not collected to correlate HPGe survey results to ^{241}Am activities The HPGe measurements identified from the previous HPGe surveys containing ^{241}Am above 10 pCi/g are included within the boundaries of the Investigation Area (Figures 1 2, and 1 3) Surface soil plots PT035, PT045, PT047, PT048, PT054, PT055, PT062 were included within the Investigation Area based on this rationale HPGe measurements collected within the study area and used to delineate the Investigation Area are provided in Figure 1 3

Surface Soil Radiological Data - Surface soil samples were collected in support of the OU2 Phase II RFI/RI (DOE, 1995a) and the OU1 Phase III RFI/RI (DOE, 1994a) Figure 1 4 provides the locations of OU2 RFI/RI (DOE, 1995a) surface soil plots and locations where results exceeded RFCA Tier I soil action levels for radionuclides Figure 1 5 provides the locations of OU1 RFI/RI surface soil plots No surface soil sample results from OU1 RFI/RI surface soil plots exceeded RFCA Tier I soil action levels for radionuclides

As detailed in the OU2 RFI/RI, surface samples were collected from 124 plots utilizing two sampling methods Colorado Department of Health (CDH) sampling method and the Rocky Flats (RF) sampling method Surface soil sample results were compared with RFCA Tier I surface soil action levels and the HPGe survey results The comparison indicated that samples collected from five 2 5-acre plots exceed the Tier I soil action levels which correlated well with the HPGe results (Figures 1 3 and 1 4) These plots include two 2 5-acre plots (PT028 and PT034) sampled under the CDH sampling program and three 2 5-acre plots (PT029, PT036, and PT046) sampled under the RF sampling program (Figure 1 4)

The RF sampling methodology consists of compositing 10 grab samples collected at the corners and center of two one-meter square grids separated by a one square meter grid to a two inch depth These sample results represents the physical averaging of activity in soils over a two square meter area The CDH sampling methodology consists of collecting 25 grab samples over the entire 2 5- or 10-acre plot (2 5-acre plot in this case) to a depth of 0 64 cm (0 25-in) The CDH sample results represent the physical average of activity over the 2 5-acre plot The discrepancy between method results of the CDH and RF methods is evident by the fact that no single plot was identified as exceeding action levels based on both sampling method results This indicates that possibly only a portion of the plots identified by the RF method may exceed action levels and/or that the exceedance may be isolated from the contiguous radionuclide contaminated area which is indicative of a radiological "hot spot" (DOE Order 5400 5) Hot spot as defined for this investigation are the RFCA Tier I action levels averaged over a 100 m^2 area for radionuclides protective of 85 millirem per year (mrem/yr) exposure to a hypothetical future resident (DOE, 1996a, per DOE Order 5400 5)

Results from these investigations were used as one source of data by the Actinide Migration Expert Panel in the generation of the surface soil ^{241}Am and $^{239/240}$Pu isoconcentration contour maps presented in the *Summary of Existing Data on Actinide Migration at the Rocky Flats Environmental Technology Site* (DOE, 1997a) These maps show elevated activities nearer the 903 Pad with decreasing activities moving eastward

1 2 2 <u>Subsurface Soils</u>

Subsurface Soil Radiological Data - Three data sources were evaluated to determine the depth of radiological contamination within the Investigation Area 1) OU2 Phase II RFI/RI borehole data (DOE, 1995a), 2) OU2 Phase II RFI/RI soil profile pits (DOE, 1995a), and 3) samples collected in support of a soil decontamination project (Rutherford, 1981)

Samples collected from soil profile pit TR08 (Figure 1 2) exceeded RFCA Tier I soil action levels to a depth of 27 centimeters (cm) (10 6 inches[in]) Soil profile pits were sampled at 3 cm (1 2 in) intervals to a total depth of 1 m (3 28 ft) Samples collected at soil profile pit TR06, located adjacent to pit TR08, were not analyzed because activities exceeded the DOT shipping requirements It is assumed that radiochemical results from pit TR06 (Figure 1 2) would also have exceeded RFCA Tier I soil action levels, if analyzed The depth of artificial fill in the Lip Area is approximately 2 cm (0 8 in) to 13 cm (5 1 in) (DOE, 1995a)

Soil samples collected beneath the 903 Pad in support of the soil decontamination project (Rutherford, 1981) exceeded Tier I soil action levels to a depth of 66 cm (26 in) This depth exceeds the 8 cm (3 in) thickness of the asphalt pad and the 20 cm (8 in) depth of artificial fill and indicates radiological contamination of artificial fill or natural undisturbed soils at the 903 Pad However, none of the 903 Pad OU2 Phase II RFI/RI soil borings detected radiological contamination in excess of Tier I soil action levels As a result, a discrepancy in the areal extent and depth of radiological contamination between these investigations exists This area is included in the Investigation Area

Asphalt Data - No data exists for the 903 Pad asphalt

Subsurface Soil VOC Data - Three sources of data were evaluated to determine the nature and extent of subsurface VOC contamination at the 903 Pad 1) OU2 Phase II RFI/RI borehole data (DOE, 1995a), 2) IM/IRA soil gas survey results (DOE, 1994b), and 3) groundwater monitoring well data Borehole sample results were compared with RFCA Tier I soil action levels which indicated that none of the samples exceeded the Tier I action levels for VOCs Borehole 06691 encountered carbon tetrachloride with a maximum concentration of 180 µg/Kg at a depth of 7 25 m (23 8 ft) with bedrock at 6 7 m (22 ft) (Figure 1 2) The soil gas survey indicated that the highest subsurface VOC concentrations were located immediately south of the southeast corner of the 903 Pad Tetrachloroethene was detected at 27,000 µg/L at a depth of 1 5 m (5 ft) However, at adjacent soil gas locations and boreholes, tetrachloroethene is either not detected or detected at very low concentrations Soil gas concentrations for the remaining portion of the 903 Pad ranged from 0 -500 µg/L with the highest concentrations around boreholes 08691 and 08891

1 2 3 Groundwater

To target subsurface soil areas with potential VOC concentrations above RFCA Tier I soil action levels, groundwater data were also reviewed The data were compiled from the OU2 Phase II RFI/RI (DOE, 1995a) and the Rocky Flats Environmental Database System (RFEDS) which indicated a VOC-contaminated groundwater plume originates from the 903 Pad area and extends to the east The highest concentrations of VOCs are found in groundwater samples collected from wells 06691 and 08891 located on the asphalt portion of the 903 Pad (see Figures 1 2 and 3 4 for well locations) Concentrations of VOCs in groundwater decrease rapidly moving eastward from the 903 Pad area This decrease in concentration may be a result of the hydraulic dispersivity reflected in the distance between the two wells and downgradient well locations

The primary groundwater contaminant in well 06691 is carbon tetrachloride with concentrations ranging from 12,000 to 100,000 µg/L Methylene chloride (150 to 35,000 µg/L) and chloroform (92 to 49,000 µg/L) are also observed Groundwater sample results for well 08891 indicate the primary contaminant as tetrachloroethene at concentrations ranging from 8,800 to 20,000 µg/L, along with carbon tetrachloride (2,300 to 17,000 µg/L), cis-1,2-dichloroethene (94 to 2,900 µg/L) and trichloroethene (1,300 to 4,600 µg/L) The next highest concentration of carbon tetrachloride in groundwater is found in samples collected from well 13191, which is located west of well 06691 and off the western edge of the 903 Pad At this location, observed carbon tetrachloride levels ranged from 122 to 4,800 µg/L

Because of the complex nature of DNAPL transport and fate, DNAPL may often be undetected by direct methods leading to incomplete site assessments and inadequate remedial designs (EPA, 1992) A guide for estimating the potential for a DNAPL source at a site includes assessing if concentrations of DNAPL-related chemicals in groundwater are greater than 1 percent (%) of the pure phase solubility of the DNAPL compound (EPA, 1992)

Table 1 1 provides a comparison of the pure phase aqueous solubility and concentrations of DNAPL compounds detected in groundwater at or near the 903 Pad The comparison indicates that tetrachloroethene and carbon tetrachloride have been detected in groundwater samples at 10% and 12% of their aqueous solubilities, respectively Based on the results of this comparison and known historical site uses, there is a high potential for DNAPL and VOC contaminants above the Tier I soil action levels beneath the 903 Pad

Radionuclide contamination in groundwater was investigated by reviewing groundwater monitoring well sample results from 1991 to 1995 Groundwater in one well, 09091 (Figure 1 2), contains ^{241}Am and $^{239/240}$Pu activity in excess of Tier I action levels for groundwater Tier I action levels for ^{241}Am and $^{239/240}$Pu are 14 5 pCi/L and 15 1 pCi/L, respectively Well 09091 has maximum activities of 354 6 pCi/L of ^{241}Am and 46 5 pCi/L of $^{239/240}$Pu Uranium isotopes have not been detected in excess of their respective background activities in groundwater samples collected over this period

Table 1 1 Comparison of Pure Phase Aqueous Solubility with Concentrations in Groundwater Samples - Selected VOCs

Compound	Pure Phase Aqueous Solubility at 25°C[1] (mg/L)	Highest Concentration Detected in Groundwater (mg/L)	Ratio Groundwater/Aqueous Solubility (%)
Carbon Tetrachloride	793	100 0	12 6
Chloroform	7,920	49 0	0 62
cis-1,2-dichloroethene	3,500	2 9	0 83
Methylene Chloride	13,000	35 0	0 27
Tetrachloroethene (PCE)	200	20 0	10 0
Trichloroethene (TCE)	1,100	4 6	0 42

[1] = EPA, 1996 Soil Screening Guidance Technical Background Document

1 3 Geologic Setting and Contaminant Summary

The surficial geology in the Investigation Area consists of Quaternary alluvium, colluvium and slump deposits along with artificial fill, soil and debris deposits, and disturbed soil The surficial deposits overlie bedrock which consists of weathered claystone and minor bedrock sandstones of the Cretaceous Arapahoe and Laramie Formations Surficial deposits consist of sandy clay and clayey gravel Soil developed over the alluvium is rocky and sandy in contrast to the clayey soils developed over the claystone bedrock

Artificial fill is present directly beneath the 903 Pad and on the surface of the Lip Area as a result of previous remediation activities In November 1968 "slightly contaminated" soil was graded from outside the fence at the 903 Pad into the fenced area to be capped In September of 1969 a base coarse material (artificial fill) overlay, soil sterilant, and asphalt primer were placed over the 903 Pad as a "containment barrier " The asphalt pad was constructed in October of 1969 and is reportedly 7 6 cm (3 in) thick The thickness of the base coarse materials beneath the 903 Pad is assumed to be approximately 20 cm (8 in) In February 1970, operations were initiated to apply additional fill (base coarse) over the Lip Area due to surficial radiological contamination This fill material ranges from 2 cm (0 8 in) to 13 cm (5 1 in) (DOE, 1995a)

The surficial soil contaminants of concern are $^{239/240}Pu$ and ^{241}Am (DOE, 1995a) $^{239/240}Pu$ is relatively insoluble and tends to be strongly absorbed to fine grained soil particles The OU2 RFI/RI (DOE, 1995a) states that 90% of the ^{241}Am and $^{239/240}Pu$ activities are concentrated in the upper 15 cm (6 in) of the soil While there is a tendency for ^{241}Am and $^{239/240}Pu$ activities to decrease with increasing distance from the source area, isolated areas in the Americium Zone show higher activities than the 903 Pad and Lip Area

Subsurface soil contaminants of concern include carbon tetrachloride, tetrachloroethene, trichloroethene, ^{241}Am and $^{239/240}Pu$ (DOE, 1995a) VOC concentrations observed in groundwater indicate that a DNAPL may be present beneath the 903 Pad area The exact location of the DNAPL has not been identified from previous investigations which have included boreholes and soil gas vapor studies It is unknown if the DNAPL has remained in the soil pore space as residual contamination, is present on the bedrock surface, or is completely dissolved in the local groundwater

Conceptual Model - Based on the existing data and geologic setting, a conceptual model for the Investigation Area was developed The contaminants present in the surface and subsurface soil are primarily a result of drum storage in the 903 Pad and Lip Area Drums containing plutonium- and uranium-contaminated volatile organic compounds leaked The liquids from the drums have moved downward towards the bedrock surface, possibly carrying a fraction of the radionuclides into the subsurface along preferential pathways such as rodent holes, desiccation cracks, and/or along decayed roots High winds and heavy rains spread the surficial radiological contamination outward from the 903 Pad, depositing it on surface soils in the Lip Area and Americium Zone

Previous HPGe surveys from the study area and surface soil sample data show that, in general, higher concentrations are present near the 903 Pad, and concentrations decrease with increasing distance from the 903 Pad Immediately east and south of the 903 Pad and Lip Area, there are areas of higher concentrations which may be the result of rain and surface water dispersion of contaminants (DOE, 1995a) Accounting for the surface soil and HPGe sampling already collected from the 903 Pad area to Indiana Street, and the direction of surface water flow from the 903 Pad towards Woman Creek, it was concluded that hot spots are not likely to be present to the east, outside of the Investigation Area

The subsurface DNAPL contamination is suspected to be present directly beneath the area where drums were previously stored The liquid contained in the drums has migrated downward towards the bedrock surface An east-west paleo-channel (medial paleoscour, Figure 3 4) is cut into the bedrock, with the greatest depth to bedrock located toward the middle of the 903 Pad The available subsurface and groundwater data (see Section 1 2) strongly indicates that the source for DNAPL contamination is limited to the area under the present 903 Pad The VOC contamination east of the 903 Pad is suspected to be limited to the dissolved phase in groundwater

2.0 DATA QUALITY OBJECTIVES

The data quality objective process consists of seven distinct steps and is designed to be iterative, the outputs of one step may influence prior steps and cause them to be refined Each of the seven steps are described below for the Investigation Area (Figure 1 2)

2.1 State the Problem

2 1 1 Surface Soils

Previous investigations in the Lip Area and Americium Zone have revealed radiological contamination in surface soils exceeding RFCA Tier I soil action levels triggering an action The exposure area (EA) of previous investigations were 2 5- and 10-acre plots The purpose of this characterization effort is to further refine the volume of soils exceeding RFCA Tier I soil action levels The volume estimate calculated from data generated from this investigation will be used for input for a remedial alternative analysis

Asphalt - Remediation of subsurface soils at the 903 Pad may require the removal and disposal of the asphalt comprising the 903 Pad Low-level waste disposal facilities require that waste be characterized, specifically that the 90% upper confidence limit of the mean be compared to waste acceptance criteria (WAC) thresholds for the contaminants of interest No data, with the exception of a 903 Pad surface gamma survey (Rutherford, 1981), currently exists for the asphalt Preliminary analytical data, specifically the mean activity and sample variance, will be required to design a statistically based sampling plan to adequately characterize the asphalt to meet the WAC of waste disposal facilities qualified to accept the waste

2 1 2 Subsurface Soils

Radionuclide Contamination - Historical data from the 903 Pad indicate radionuclide activities above background in soils to 66 cm (26 in) below the asphalt pad, however, an evaluation of OU2 RFI/RI borehole data reveal no subsurface soil samples exceeded the Tier I soil action levels Because radionuclides are suspected to have been transported with the solvents released at the 903 Pad, additional data are needed to resolve this discrepancy and to determine the depth of radiological contamination Data collected will be compared to RFCA Tier I soil action levels

Evaluations of the OU2 Phase II RFI/RI (DOE, 1995a) surface soil data indicated 5 Plots (Figure 1 5), each with an area of 2 5-acres, exceeded the RFCA Tier I soil action levels The soil samples used for the evaluation were collected to 0 64 cm and 5 1 cm (0 25 in and 2 0 in) depth using the CDH and RF sampling methods, respectively Resolution of the vertical extent of contamination is currently inadequate for soil volume estimates and related remediation costs Therefore, determination of the extent of radiological contamination at a large scale is required to determine the volume of soils exceeding Tier I soil action levels for remedial alternative analysis

Lastly, surface soils in the Lip Area have been disturbed by historical activities associated with stabilization of radiological contamination at the 903 Pad In 1969, contaminated surface soils in the Lip Area were graded into the 903 Pad prior to covering the soils with an asphalt cap Subsequent to grading the Lip Area, the surface was covered in 1970 with an artificial fill to prevent wind erosion and transport of contaminated soils from the Lip Area Previously uncharacterized contaminated soils may exist below the artificial fill These soils are potentially contaminated above Tier I soil action levels Artificial fill potentially covers contaminated soils in areas remediated in 1976, 1978, and 1984

VOC Contamination - Existing VOC data collected from boreholes were compared to Tier I soil action levels and the results of the comparison indicate that no soil sample exceeds Tier I soil action levels However, groundwater data indicates the potential for DNAPL Additional information is required to determine the location and depth of VOC contamination in subsurface soils

2 2 *Identify the Decision*

2 2 1 Soils

Decisions required to be made using the data collected for surface and subsurface soils include

- Do activities of radiological contaminants in soils equal or exceed the RFCA Tier I Soil Action Levels, and if they do to what is the areal and vertical extent?
- Do VOCs beneath or adjacent to the 903 Pad exist at concentration equal to or exceeding the Tier I soil action levels, and if present what is the areal and vertical extent?

Actions based on the decisions include an evaluation, remedial action, or management action of soils identified as exceeding Tier I soil action levels or other action levels identified as being protective of surface water Final remedial actions or no further action determinations will be incorporated into the Buffer Zone OU Record of Decision (ROD)

2 2 2 Asphalt

The decisions to be made based on the asphalt sampling are is the sample variance and mean values calculated from sample results collected per this SAP demonstrate adequate characterization and potential treatment of the 903 Pad asphalt to meet a waste disposal facilities WAC requirements

2 3 *Identify Inputs to the Decision*

2 3 1 Soils

Inputs to the decision include radiochemical and chemical results from surface and subsurface soil samples for comparison to RFCA Tier I action levels The parameters of interest include the activity/concentrations of the following radionuclides/contaminants in surface and subsurface soils

- $^{239/240}Pu$,
- ^{241}Am,
- Uranium-234 (^{234}U),
- Uranium-235 (^{235}U),

- Uranium-238 (^{238}U), and
- VOCs (subsurface soils only)

Field sampling techniques and analytical methods were selected to collect the necessary data to compare to RFCA Tier I action levels Methods with quantitation limits (organics) and minimum detectable activities (MDA) below action level thresholds were selected Table 2 1 provides mid-range quantitation limits and Tier I soil action levels for VOCs suspected to be present within the Investigation Area Table 2 2 provides the MDAs, and RFCA Tier I soil action levels for radionuclides The direct method (HPGe) MDA for $^{239/240}Pu$ exceeds the action level threshold, however, indirect methods (calculated from the ^{241}Am activity) will allow detection of $^{239/240}Pu$ to approximately 7 pCi/g (assuming a $^{239/240}Pu$ to ^{241}Am activity ration of 7 0) In addition, due to masking of the ^{234}U activity by ^{238}U, the ^{234}U activity will be estimated from the ^{238}U activity (assuming equilibrium/activity ratio of 1 0) Therefore ^{234}U will have a estimated MDA equal to ^{238}U at 5 pCi/g

Sample quantities and analytical methods are provided in Tables 3 2 through 3 5 Land survey data will also be used to control sample locations

Asphalt - Inputs to the decision include radiochemical data to include the activities of the following radionuclides

- ^{241}Am,
- $^{239/240}Pu$,
- $^{233/234}U$
- ^{235}U, and
- ^{238}U

2 4 *Define the Investigation Boundaries*

The investigation boundaries and rationale for the boundaries selected are detailed in Section 1 1 3 and in Figures 1 1, 1 2, 1 4, 3 1, 3 2, and 3 4

Table 2 1 Analytical Quantitation Limits - VOCs

Compound	Tier I Action Level (mg/kg)	Method 8260B Quantitation Limit (ug/kg)
Carbon Tetrachloride	11 00	500
Chloroform	152 00	500
cis-1,2-dichloroethene	9 51	500
Methylene Chloride	5 77	500
Tetrachloroethene (PCE)	11 50	500
Trichloroethene (TCE)	9 27	500

Table 2 2 Minimum Detectable Activity - Radionuclides

Radionuclide	Tier I Soil Action Level (pCi/g)	HPGe MDA[1] (pCi/g)	Alpha Spectrometry MDA (pCi/g)
Am-241	215	1	0 3
Pu-239/240	1,429	3,500[2]	0 3
U-234	1,738	250[3]	1 0
U-235	135	0 5	1 0
U-238	586	5	1 0

[1] Minimum detectable activity of direct reading (based on 15 minute count time and a bare 75% N-type HPGe)

[2] Indirect methods (estimated from ^{241}Am) will allow detection of $^{239/240}$Pu to approximately 7 pCi/g

[3] Indirect methods (estimated from ^{238}U) will allow detection of ^{234}U to approximately 5 pCi/g

2.5 Develop a Decision Rule

2 5 1 Radionuclides

The decision level is based on a summary evaluation of activities of radionuclides in surface and subsurface soils as defined in RFCA (DOE, 1996) If a mixture of radionuclide contaminants a, b, c are present in the soil with activities a_a, a_b, and a_c, and if the applicable action level of radionuclide in soil, as stated in RFCA, is A_a, A_b, and A_c respectively, then the activity in the soil shall be limited so that the following relationship exists

$$\frac{a_a}{A_a} + \frac{a_b}{A_b} + \frac{a_c}{A_c} \leq 1 \qquad \text{(Eq 2 1)}$$

Table 2 2 provides the Tier I radionuclide soil action levels for Open Space Use (DOE, 1996a) The Tier I soil action level sum of ratios equation (in units of pCi/g) is provided below as equation 2 2

$$\frac{Am-241}{215} + \frac{Pu-239/240}{1429} + \frac{U-234}{1738} + \frac{U-235}{135} + \frac{U-238}{586} = \text{Sum of Ratio of Tier I Action Level} \qquad \text{(Eq 2 2)}$$

If individual radionuclide activities in surface or subsurface soils equal or exceed the RFCA Tier I soil action levels, or the sum of their respective ratios exceed 1, an evaluation, remedial action, or management action is required If individual radionuclide activities are below the Tier I soil action levels or the sum of ratios is less than 1, or below other action levels identified as being protective of surface water, the soils will not require an accelerated action and will be addressed under the Buffer Zone OU ROD

2 5 2 Volatile Organic Compounds

The decision level is based on concentration of volatile organic compounds in soils as defined in RFCA (DOE, 1996) If the concentration of VOCs in soils equal or exceed the RFCA Tier I soil action levels for subsurface soils, an action must be taken Table 2 1 provides the Tier I soil action levels for VOCs suspected to be present in soils at the 903 Pad

2 5 3 Asphalt

Waste disposal facility's WAC require generators to adequately characterize waste shipments with respect to their WAC This sampling effort is designed to collect preliminary characterization data These data will be evaluated statistically to determine the total number of samples required to characterize the asphalt After evaluating the characterization data, additional waste characterization samples, if required, will be collected during the remediation of the 903 Pad

2 6 *Specify Limits on Decision Errors*

2 6 1 Surface Soils

HPGe Survey - As discussed in Section 3 0, HPGe survey coverage will directly measure 74% of the total area surveyed with tangential circular FOVs The remaining 26% of the area are the non-surveyed diamond-shaped interstices between FOVs To minimize the decision error, non-survey areas adjacent to HPGe measurements which exceed action levels will be assumed to also exceed action levels HPGe measurements will provide *in situ* ^{241}Am, ^{235}U, and ^{238}U activities for comparison with soil sample results

Surface Soil Samples - Fifteen (15) selected HPGe locations will have three soil samples collected, for a total of 45 samples, from the same depth interval as the HPGe measurement for alpha spectroscopy analysis in a fixed laboratory The isotopic results will be correlated with HPGe measurements over similar intervals Surface soil samples for isotopic analysis will be collected from pre-determined HPGe ^{241}Am activity intervals The upper 95% confidence limit of the linear regression between the two measurements will be determined for inclusion of radionuclide activities into the RFCA sum of ratios equation

2 6 2 Subsurface Soils

Two aspects of the subsurface soil sampling design were evaluated relative to the confidence of contamination detection and subsequent project decisions 1) grid density/spacing, and 2) number of samples needed The grid densities/spacings and total number of samples represent an optimum compromise between cost (restraints) and an acceptable confidence (power of 90%) of detecting contaminants of concern within the soil volumes of interest Table 2 3 indicates the number of samples needed to provide a range of confidences that the mean value of the most toxic VOC of concern (CCl_4) is below the RFCA Tier I action level (11 mg/Kg) This calculation is based on historical subsurface soil data (DOE, 1995a) in the study area and the equation promulgated by EPA for optimizing sample quantities relative to action levels (EPA {G-4}, 1994) Lognormal transformations were performed with the G-4 calculation based on lognormality of the VOC data (specifically CCl_4 and PCE)

This SAP provides an adequate number samples to exceed a 90% confidence that mean values of VOCs are less than RFCA Tier I action levels (compare Table 3 4 sample quantities with Table

2 3) The number of radionuclide samples planned, likewise, will exceed a calculated 90% confidence level The distribution resulting from historical subsurface radionuclides (^{241}Am in particular) was bimodal due primarily to nondetects combined with 8 samples collected immediately beneath the 903 Pad that were up to 4 orders of magnitude higher than the majority of OU-2 subsurface samples Given this particular distribution, the calculated numbers of samples needed (Table 2 3) are semi-quantitative, but are useful as indicators (compare Table 3 5 sample quantities with Table 2 3)

Table 2 4 displays the grid density and spacing specifications for both the 903 Pad and the Lip Area This same grid density and spacing may be used for the Americium Zone depending on the results of the HPGe survey Systematic grid sampling was selected as the design of choice based on one of the primary objectives of this project to estimate, with quantifiable error, the location(s) and volume of soils (surface and subsurface) that must be remediated due to contaminant levels (VOCs and radionuclides) that exceed applicable action Statistical studies indicate that this approach is preferred over other designs for estimating means, totals, and patterns of contamination (Gilbert, 1987) Further, a systematic grid pattern is essential for quantifying the "consumer's risk" associated with the design, i e , to address the question What is the probability of missing contamination (consumer's risk), within the sampling boundaries, with a given size, shape, and concentration? Consumer's risk, within an environmental restoration scenario, may be thought of as the risk assumed by the public (and regulators)

Table 2 4 specifies the dimensions of areas of contamination that can be detected, and the associated risk of non-detection (Beta Error) While these dimensions may seem coarse, it should be noted that the overall number of samples taken is more than is necessary (discussed above) given the low mean values of historical data relative to current RFCA Tier I action levels Additionally, sample locations with concentrations greater than action levels will be "stepped-out" one-half the distance to the next grid node *without detection* for an additional sampling location This optimization of the grid sampling is further discussed in Section 3 2 Relative to costs, as the grid spacing is cut in half, the number of samples roughly doubles and consequent sampling costs also roughly double, such a relationship represents the issue between improving the resolution of contaminant detection and keeping project costs under control

Table 2 3 Surface and Subsurface Soil Sample Confidence Calculations

Surface Soils, CDH Method	**AM-241** (pCi/g) normal	nat log log trans	**U-238** (pCi/g) normal	nat log log trans	Subsurface Soils **PCE** (ug/kg) normal	nat log log trans	**CCl4** (ug/kg) normal	nat log log trans	**AM-241** (pCi/g) normal	nat log log trans	**U-238** (pCi/g) normal	nat log log trans	**U-235** all <0.3 all <0 3
$(std\ dev)^2$ =	968 3	4 5	12752 0	0 5	276 9	0 5	2035 7	1 5	141088	9 8	0 1	0 2	
N =	116	116	116	116	43	43	43	43	87	87	84	116	
Z score (85% CL)	1 035	1 035	1 035	1 035	1 035	1 035	1 035	1 035	1 035	1 035	1 035	1 035	
Z score (90% CL)	1 28	1 28	1 28	1 28	1 28	1 28	1 28	1 28	1 28	1 28	1 28	1 28	
Z score (95% CL)	1 645	1 645	1 645	1 645	1 645	1 645	1 645	1 645	1 645	1 645	1 645	1 645	
mean	8 803006	-0 0803	12 0169	0 4145	9 97727	1 89907	23 4091	2 161	90 60264	-2 22681	0 84592	-0 2512	
Action Level (Table ES-1)	209	2 32015	506	2 70415	11500	4 0607	11000	4 04139	209	2 32015	506	2 70415	
EPA G-4, Aped C													
85% CL	1	49	1	3	1	3	1	11	44	13	1	2	
90% CL	1	382	1	4	1	5	1	38	67	51	1	3	
95% CL	2	18364	2	12	1	14	1	399	110	665	1	5	

Table 2 4 Circular Contamination Geometry - Subsurface Investigation[(1)]

Area	Grid (ft)	Diameter (ft)	L (ft)	S	L/G	Beta Error
903 Pad	75	82	41	1	0 55	10%
Lip Area	151	166	83	1	0 55	10%

S = (length of short axis)/(length of long axis)
L = ½ length of long axis of ellipse
G - Grid Space
[(1)]Calculations based on Chapter 10, Gilbert, 1987

Because higher concentrations and occurrences of radionuclides in the subsurface beneath the 903 Pad are anticipated (DOE, 1996, RMRS, 1997), the grid sample density for the 903 Pad is twice that of the outlying Lip Area The radionuclide sampling program is based on the placement of 25 boreholes on a grid spacing of 75 feet over the 3 4 acre area of the 903 Pad Consumer's risk (Beta error) is set at 10% for all grid spacing evaluations

VOC borehole location placement is based on a subjective, or "judgment", sampling design on the basis of groundwater data and areas of drum storage from aerial photographs All areas of interest are completely accessible so that location bias is not a problem, the locations were chosen for their unique value and representation, especially groundwater contamination, rather than for drawing inferences about a wider population

The quality control (QC) samples for the project will include a 1 in 20 frequency for duplicate samples and equipment rinsates, a trip blank will be provided for each sample shipment for VOC analysis Relative percent difference (RPD) goals for soils will be 40% for non-organics and 30% for organics The duplicated error ratio for radionuclides shall be 1 42 A completion goal for the project will be 90% The completion goal means that 90% of the data collected, analyzed, and verified will be of acceptable quality for decision making Twenty-five percent of the total analytical data will undergo validation by a third party The remaining 75% of the data will be verified

2 6 3 Asphalt

There will be no limits on decision errors for the asphalt sampling

2 7 *Optimize the Design for Obtaining Data*

2 7 1 Surface Soils

This SAP will use a linear regression double sampling technique to estimate the activity of actinides in surface soils The double sampling method (Gilbert, 1987) was selected because there is a strong linear correlation between ^{241}Am and $^{239/240}Pu$ in the Investigation Area surface soils The process flow for quality control of HPGe measurements is shown in Figure 2 1

HPGe measurement will determine activities of ^{241}Am, ^{235}U and ^{238}U in surface soils The sum of ratios equation requires input activities for ^{241}Am, $^{239/240}Pu$, ^{234}U, ^{235}U, and ^{238}U Therefore, activities for $^{239/240}Pu$ and ^{234}U will be required to complete the sum of ratios calculation $^{239/240}Pu$ and ^{241}Am are known to have a linear relationship and a high coefficient of correlation Two hundred and eleven surface soil samples collected in support of the OU2 Phase II RFI/RI produced a correlation coefficient of 0 96 when $^{239/240}Pu$ was regressed from ^{241}Am ^{241}Am activities in surface soils can be measured with less expensive *in situ* gamma-ray spectroscopy methods to determine $^{239/240}Pu$ concentration rather than $^{239/240}Pu$ concentrations determined from expensive radiochemical techniques performed in a laboratory

The $^{239/240}Pu$ soil sample results from the laboratory and the HPGe ^{241}Am measurements will be correlated through linear regression to determine the relationship between the two radionuclides activities The quantitative relationship will allow determination of $^{239/240}Pu$ in soils from HPGe ^{241}Am measurements for consequent comparison with RFCA Tier I soil action levels for the Buffer Zone (hypothetical resident, 85 millirem annual dose) based on HPGe measurements alone

Activities of ^{234}U will be determined from ^{238}U results, based on the fact that ^{234}U is in equilibrium with ^{238}U Equilibrium between a parent (^{238}U) and daughter (^{234}U) indicates that the activity ratio between these two isotopes should be near 1 0 Analytical data collected in support of the OU2 Phase II RFI/RI CDH surface soil sampling program (DOE, 1995a) supports this relationship with an mean activity ratio of 0 97 between the two isotopes Activities of ^{234}U will be estimated from ^{238}U results

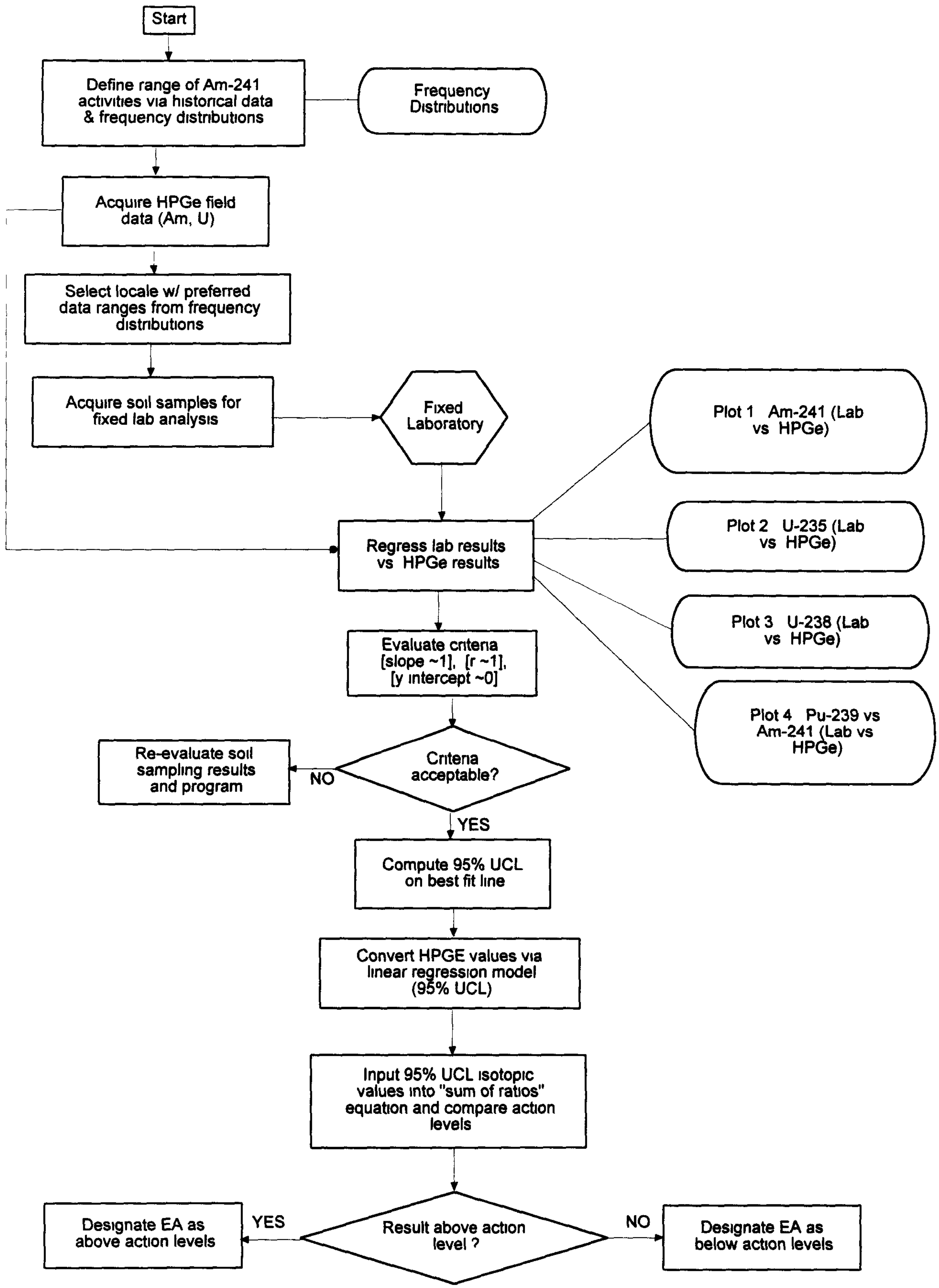


FIGURE 2 1
PROCESS FLOW FOR CORRELATION OF HPGe MEASUREMENTS TO FIXED LAB RESULTS

The OU2 Phase II RFI/RI report states that 90% of the total actinide activity is located in the top 15 cm (6 in) of soils Further evaluation of data for soil profile Pits TR04, TR05, TR09, TR11, and TR12, all of which are located within undisturbed areas in the Investigation Area, indicates that 70 to 88% of the total actinide activity is in the upper 6 cm (2 4 in) of soils Therefore, soil samples will be collected to a depth of 5 cm (2 in) for correlation with HPGe measurements HPGe results will be integrated over a depth of 5 cm (2in) The 5 cm (2 in) depth was selected based on the fact a majority of the activity is in the upper 2 4 cm (1 in) and that numerous OU2 RFI/RI surface soil data, collected from 0 - 5 cm (0 - 2 in), currently exists in the study area for comparison purposes The detection frequency of OU2 surface soil ^{241}Am is provided in Figure 2 2

2 7 2 Subsurface Soils

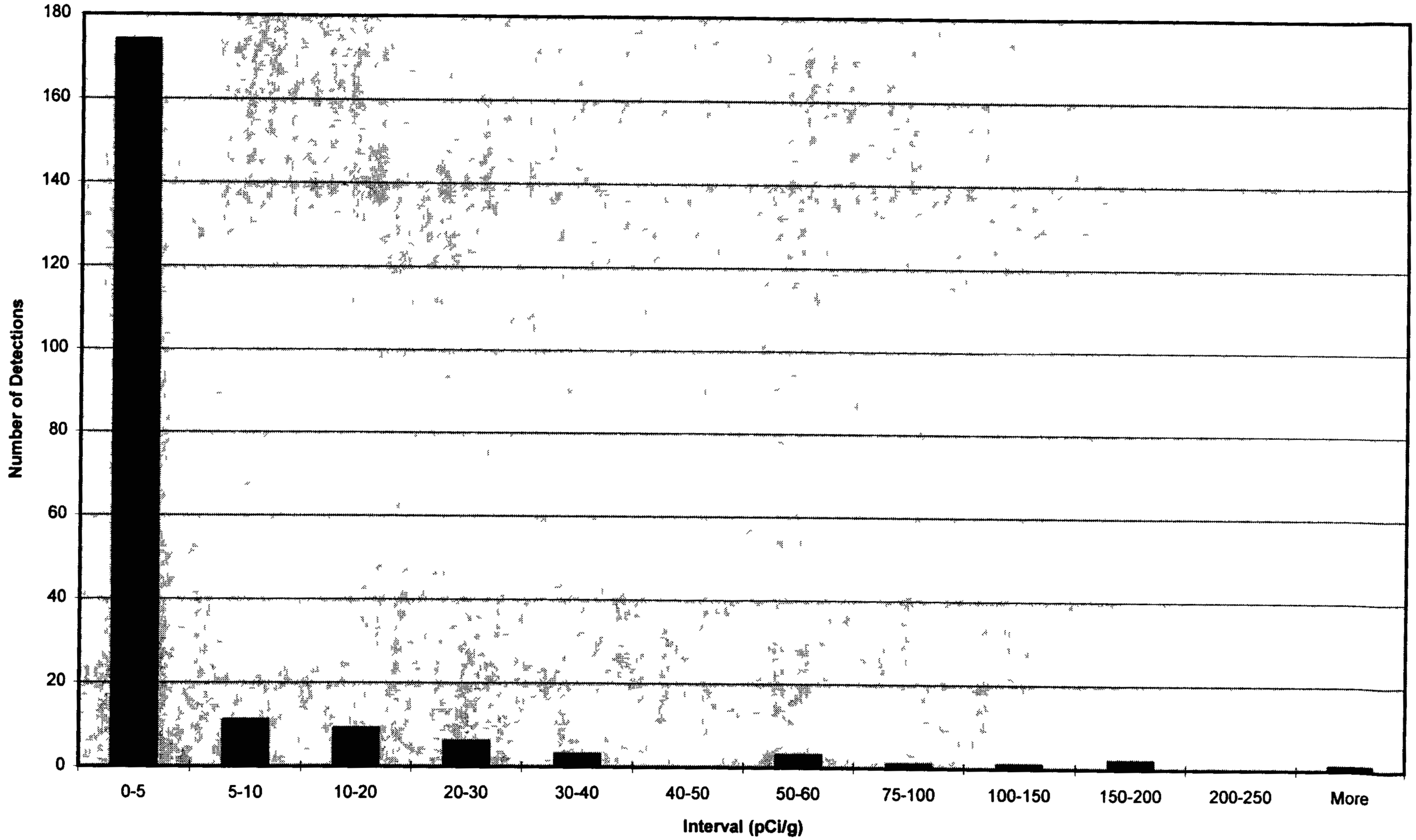
Determination of the vertical and thus the areal distribution of radiological contaminants will be optimized through a "step-out" boring approach This will be implemented by the placement of a boring half way between locations exhibiting radiological contaminants above and below Tier I soil action levels respectively Only one "step-out" boring will be completed per original grid sample location, as needed

Determination of the vertical and areal extent of VOC contaminants will be optimized through a "step-out" boring approach This will be implemented by the placement of a boring upgradient of a boring with analytical results indicating VOCs are above 10 % of the RFCA Tier I action level The sampling grid will be extended an additional 6 1 m (20 ft) in an upgradient direction (based on the potentiometric surface, [DOE, 1995]) of that location and additional samples will be collected for laboratory analysis

3.0 SAMPLING AND ANALYSES - STRATEGY AND DESIGN

Radiological contamination in the Americium Zone surface soils will be evaluated using HPGe *in situ* gamma-ray spectrometry methodology Subsurface soil samples will be collected to further refine the depth of radiological contamination HPGe results will be correlated to radiochemical data by the analysis of surface soil samples collected from 15 HPGe survey measurement locations The soil samples will be collected over the same depth interval as the HPGe measurement

FIGURE 2 2
FREQUENCY OF AM-241 DETECTIONS IN SURFACE SOILS
CDH AND RF SAMPLING METHOD RESULTS



The vertical and lateral extent of radiological and VOC contamination at the 903 Pad and Lip Area will be assessed utilizing Geoprobe® or conventional hollow-stem auger drilling techniques to collect subsurface soil samples for analysis Asphalt samples from the 903 Pad will be collected to obtain a preliminary waste characterization data for disposal purposes Field activities will be performed in accordance with FO 1, Air Monitoring and Particulate Control

3.1 Radiological Contamination

The areal extent of radiological surface soil contamination will be primarily assessed using a non-intrusive *in situ* gamma-ray spectrometry techniques (i e , HPGe survey) and collection of surface soil samples for isotopic laboratory analysis for correlation of the HPGe results Vertical and areal extent of radiological contamination will be assessed with subsurface soil samples submitted for isotopic laboratory analysis using alpha spectrometric methods Follow-up FIDLER surveys may be performed to further refine the areal extent of radiological contamination

3 1 1 Surface Soil Investigation

The surface soil investigations will be implemented by performing an HPGe survey and collecting surface soil samples at HPGe measurement locations with predetermined ^{241}Am activities The soil sample results and HPGe measurement results will be correlated to estimate activities of radionuclides for input into the RFCA sum of ratios equation

Field Preparation - Reference stakes for the HPGe grid will be placed in the field before and during data collection activities From these stakes, the HPGe survey grid will be laid out using tape and compass methods, at the 12 m spacing specified below Each measurement point will be staked, flagged, and numbered for reference by the HPGe crew

HPGe Survey - The HPGe survey will be initiated in the Americium Zone adjacent to the Lip Area's eastern boundary in this area and proceed eastward Subsurface soil results are required in the Lip Area prior to performing the HPGe survey In the Lip Area it will be assumed that if subsurface soil contamination exists, the overlying surface soils will require similar remedial action and these soils and will be included into the volume estimate of soil exceeding the Tier I action level HPGe surveys will therefore not be required in portions of the Lip Area where subsurface soils exceed Tier I action levels Figure 3 1 shows the configuration of a typical HPGe survey grid

The tripod-mounted HPGe system will be used to determine the average ^{241}Am activity over a FOV with a diameter of 12 meters (39 4 ft) and an area of 113 m^2 (1,217 ft^2 or 2 8 x 10^{2} acre) with a detector height of 1 m (3 28 ft) above the ground surface Thus the EA has been defined to be single HPGe measurement with a FOV of 12 m (39 4 ft) in diameter A 12 m grid spacing to achieve 74% coverage translates to 81 HPGe measurements for complete coverage of a 2 5-acre area Table 3 1 provides an estimate of the number of HPGe measurements proposed in the Lip Area and Americium Zone (assuming full coverage is required)

Table 3 1 Surface Soil Investigation - Field Program

Area	HPGe Measurements (Estimated)	Surface Soil Samples[1] (Estimated)
903 Pad	0	0
Lip Area	500	0
Americium Zone	1000	45

[1] = A minimum of 45 surface soil samples will collected to correlate HPGe measurements

Measurement count times will be approximately 15 minutes to ensure a 95% confidence level of the HPGe to determine ^{241}Am activities in soils to 1 pCi/g Complete HPGe coverage of the proposed Investigation Area, if required, is estimated to require approximately 1,500 measurements The HPGe survey will be discontinued in a given direction when two consecutive and adjacent measurements are less than 10 pCi/g ^{241}Am Soil moisture measurements will be collected from a representative number of sample nodes The number of nodes required will be determined based on variability of initial measurements and environmental parameters (i e , precipitation) A moisture-density gauge, or equivalent, will be used for soil moisture measurements in accordance with the manufacturer's specifications HPGe locations and elevations will be surveyed by land survey methods or with a Global Positioning System (GPS) operated in accordance with the manufacturers specifications

FIDLER Surveys - A follow-on FIDLER survey may be conducted in selected areas where contiguous or isolated HPGe measurements exceed the 10 pCi/g ^{241}Am decision level An evaluation of the nature of the exceedence will be conducted to determine if detailed FIDLER surveys are required If an HPGe measurement for an individual FOV is above the decision level, and adjacent FOVs are below the decision level, a FIDLER survey will be conducted to determine if the high FOV measurement is caused by the presence of a smaller area containing a hot spot In addition, detailed FIDLER surveys will be conducted at three locations where HPGe measurements for individual and surrounding FOVs exceed the RFCA Tier I action level The purpose of the survey is to determine whether the contamination is homogeneous and widespread as suggested by the conceptual model, or heterogeneous and consists of numerous individual hot spots

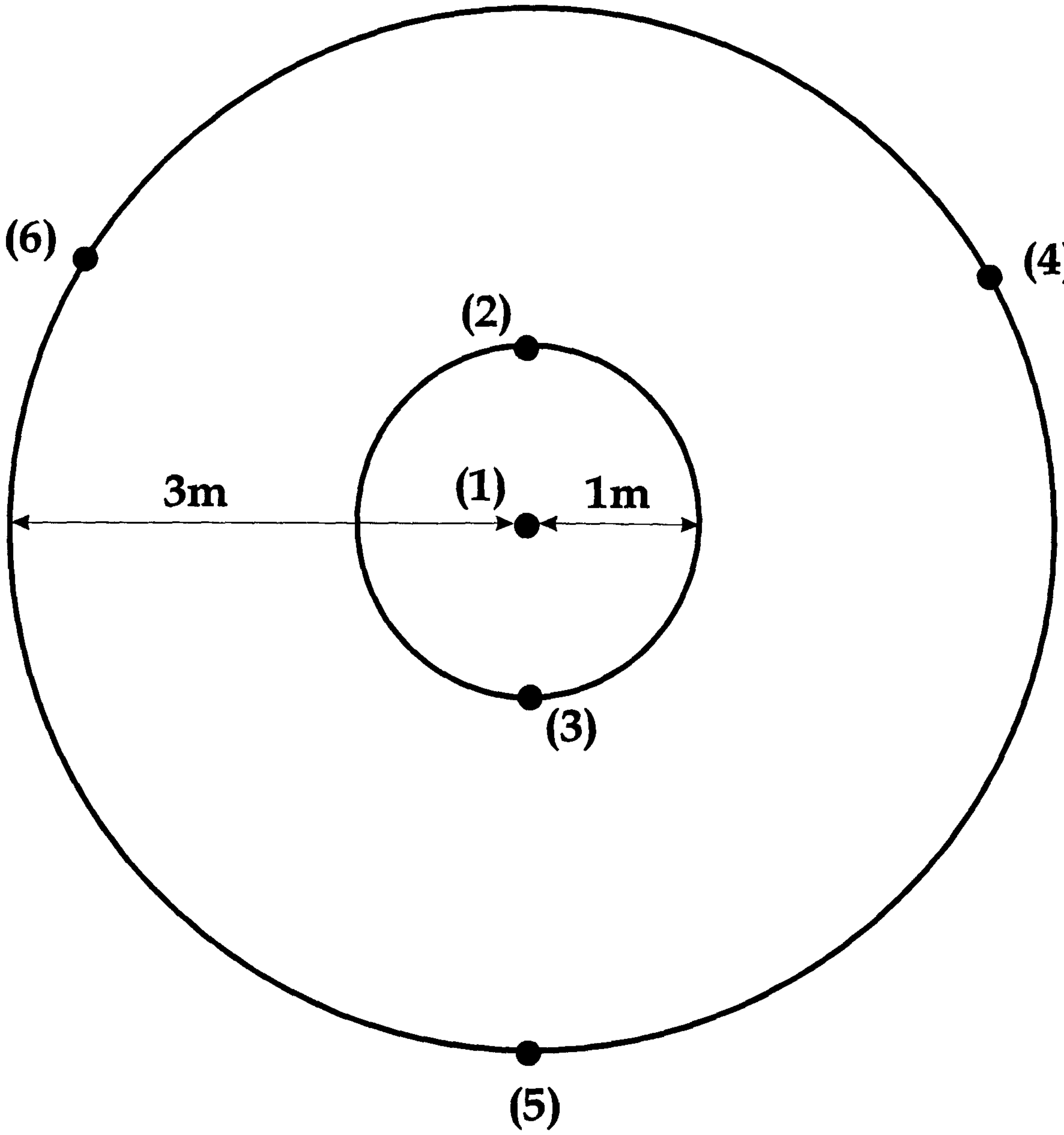
A grid with four-foot spacings will be staked in the field for the FIDLER survey While all available data will be used to determine whether a FIDLER survey is required, it is anticipated that these will be conducted only in areas where HPGe measurements are above the decision level of 10 pCi/g, ^{241}Am When performing a FIDLER survey, measurements will be taken with the instrument placed on the ground surface at each of the four-foot grid nodes When walking between grid nodes, the operators will move their instruments slowly and observe the instrument response between readings If a sharp increase in the reading is seen between grid nodes, the surrounding area will be investigated The FIDLER surveys will be conducted in accordance with Radiological Operating Instructions (ROI) Manual, 4-H58-ROI-06 6, Use of Bicron FIDLER and will be used to locate smaller areas of increased radiological activity such as would be caused by a hot spot

The FIDLER readings will be used to define localized areas with higher readings and will be marked as potential hot spots Potential hot spots and areas of higher concentrations identified during the hand-held FIDLER survey will then be staked, surveyed and labeled for future evaluation For each hot spot, additional soil samples may be collected for isotopic analysis if it is determined that this information is necessary to determine whether a remedial action is required, or to disposition the soil from a remedial action

Surface Soil Samples - Surface soil samples will be collected using a geometry developed by the DOE (DOE, 1997b) at the Fernald Environmental Management Project site in Ohio in an effort to correlate HPGe results to surface soil results The sampling method involves the collection of 6 soil subsamples for a given HPGe measurement FOV for radiochemical analysis The location and number of subsamples collected relative to HPGe measurements is based on the theory of *in* *situ* gamma-ray spectroscopy and is expected to be representative of radionuclide contamination over the FOV Figure 3 2 provides the surface soil sampling scheme for collection of the soil sample Six grab samples will be collected at a selected HPGe location, one grab sample from the center, two grab samples collected at 1 m radius, and three grab samples from 3 m radius The 1 and 3 m radius grab samples will be composited into a 1 m and 3 m sample representative of the individual band Therefore, three separate alpha spectroscopy analyses will be performed at each selected HPGe location

Fifteen (15) selected HPGe locations will have three soil samples collected, for a total of 45 samples, and analyzed by alpha spectrometry to determine ^{241}Am, $^{239/240}$Pu, $^{233/234}$U, ^{235}U, and ^{238}U The locations of soil samples will be based on the results of the HPGe measurement's ^{241}Am activity In order to acquire a good correlation over the anticipated range of ^{241}Am activities, soil samples will be collected over 11 ^{241}Am activity intervals, 0-5, 5-10, 10-20, 20-30, 30-40, 40-50, 50-75, 75-100, 100-150, 150-200, greater than 250 pCi/g Two soil samples will be collected in the 0-5, 5-10, 10-20, 20-30 intervals to provide more control of the regression at activities near the investigation boundary action level (10 pCi/g) These intervals were selected based on the detection frequencies of ^{241}Am from CDH and RF surface soil samples collected in support of the OU2 Phase II RFI/RI (DOE, 1995a) The detection frequency of OU2 surface soil ^{241}Am is provided in Figure 2 2 These intervals provide full coverage over the range of known activities of ^{241}Am detected in the study area

Samples will be collected in a "bullseye" pattern to mimic the averaging done by the field HPGe detector over the FOV The HPGe detector receives gamma-ray photons from every point within the circle, however, it receives more gamma rays from soil closer to the detector than from soil further from the detector If the circle is divided into concentric bands, the relative weighting factor for each band can be calculated based upon the percentage influence of gamma photons at the detector which originates from a given band of soil, assuming a uniform source distribution with depth and a one MeV photon energy The relative weighting factor is the relative importance of each band with respect to the probability of gamma-rays emitted from within that band being detected by the HPGe The sample results are divided by the weighting factor per band, then products are summed to determine the activity of the soils in the FOV area



6-Point Sampling Pattern

Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Legend

● Grab Sampling Location

Figure 3 2 Surface Soil Sampling Scheme

Table 3 2 provide the results of these calculations and the weighting factors per sample will be used to calculate the weighted statistical data Table 3 3 provides the analytical program for surface soil samples The results of the HPGe measurements and soil samples will be utilized to establish the correlation between the two methods to estimate $^{239/240}$Pu activities at locations where only HPGe measurements are obtained

Table 3 2 Surface Soil Samples, Weighted Average Calculations

No. of Subsamples	Horizontal Distance from Point Under Detector (m)	Weight (per circle)
1	0	0 1
2	1	0 36
3	3	0 54
6	Totals	1 00

Table 3 3 Surface Soil/Asphalt - Analytical Program

Analytical Method	Analytes	Container	Preser-vative	Holding Time
Radiological Screen	Gross Alpha/Gross Beta	60-ml glass jar	None	6 months
Alpha Spectroscopy	Plutonium-239/240, Americium-^{241}, Uranium Isotopes	250-ml wide mouth glass or poly jar	None	6 months

Surface soil sampling locations will be selected based on the HPGe results obtained in the field Ranges for HPGe concentrations are based on the previous HPGe ^{241}Am activities from the Americium Zone The first sample will be collected from directly below the HPGe tripod setup location Sampling will then proceed radially outward in the pattern as shown on Figure 3 2

Sample locations will be pre-surveyed with the FIDLER and results recorded in the sample collection log or field logbook Samples will be collected per GT 08, Surface Soil Sampling, Section 4 3, Grab Sampling, with the following modifications Samples will be collected from 0 to 5 cm (2 in) depth using a 7 6 cm (3 in) diameter, polybutyrate or brass liner with or without a split barrel sampler, as conditions require, with a drive hammer Individual samples will include organic material and will include coarse material (gravel size fraction or larger) Samples will be prepared in the laboratory by crushing to promote homogeneity and representativeness of the sample prior to alpha spectroscopy analysis Soil moisture measurements will be collected from each surface soil sampling area with a moisture-density gauge operated in accordance with the manufacture's specifications A single soil and air temperature measurement will be recorded for each surface soil sampling area

Sample locations will be identified with the unique location number assigned, with indelible ink or paint pen either on a wooden lathe or pin flag Sample locations will be surveyed for location and elevation using standard land surveying techniques or GPS receivers operated in accordance with the manufacturer's specifications

Asphalt Samples - Asphalt samples from the 903 Pad will be collected to obtain preliminary estimates of the samples variance and mean for waste characterization purposes Random sampling techniques are appropriate methods for estimating the population mean and determination of total amount of contaminants present as well as calculating the standard errors of these two estimates Nine asphalt samples will be collected from sample locations randomly selected from the twenty-five 903 Pad subsurface soil sampling locations as shown in Figure 3 3 Table 3 2 provides the analytical program for asphalt samples

3 1 2 Subsurface Soil Investigation

The depth of radiological contamination is required to estimate the volume of soil requiring remedial action The depth of radiological contamination will be investigated at the 903 Pad, Lip Area, and Americium Zone where the HPGe has identified surface soils equal to or greater than the Tier I soil action levels

Table 3 4 provides an estimate of the number of boreholes and samples required to complete the subsurface soil investigation program Table 3 5 provides the subsurface soil investigation analytical program Figure 3 3 provides the radiological subsurface sampling locations for the 903 Pad and Lip Area

903 Pad - Twenty-five shallow boreholes are proposed for the characterization of radionuclide contamination beneath the 903 Pad Twenty-five boreholes over the 3 4-acre 903 Pad represents a borehole completed at each node of a 23 m by 23 m (75 ft by 75 ft) grid Table 2 4 shows the diameter and error associated with detecting circular areas of contamination

Table 3 4 Subsurface Soil - Field Program

Area	Number of Boreholes	REAL Samples	Duplicate Samples	Rinse Samples	Trip Blanks (VOC only)	Total Samples
903 Pad	25 - Radiological Investigation	150	8	8	0	166
903 Pad	12- VOC Investigation	72 (rad) [1] 72 (VOC) [2]	4 4	4 4	0 12 (est)	80 92
Lip Area	25-Radiological Investigation	100	5	5	0	110
Lip Area	1 - VOC Investigation	6 (rad) [1] 6 (VOC) [2]	1 1	1 1	0 1	8 9
Americium Zone	TBD [3] - Borings based on results of HPGe survey	TBD	TBD	TBD	TBD	TBD

[1] - Borehole samples collected for radiochemistry during the VOC investigation
(est) - estimated
[2] - Boreholes samples collected for VOC analysis during the VOC investigation
[3] - TBD - To be determined following analysis of HPGe survey data
Approximately 373 samples will be collected for radiological screening analysis for Department of Transportation shipping requirements

Table 3 5 Subsurface Soil - Analytical Program

Analytical Method	Analytes	Container	Preservative	Holding Time
Radiological Screen	Gross Alpha/Gross Beta	60-ml glass jar	None	6 months
Alpha Spectroscopy	Plutonium-239/240, Americium-241, Uranium Isotopes	250-ml wide mouth glass or poly jar	None	6 months
SW-846 Method 8260A	Volatile Organic Compounds	120-ml capped core, 60-ml wide mouth glass jar Teflon lined closure	Cool, 4° C	14 days
SW-846 Method 8260A (DNAPL, Trip and Rinse Blanks)	Volatile Organic Compounds	3 x 40-mL glass, Teflon lined septa cap	Cool, 4° C HCl, pH<2	14 days

SW-846 (EPA, 1986), Test Methods for Evaluating Solid Waste

Subsurface soil samples will be collected from artificial fill material and natural soils beneath the 903 Pad for radiochemical analysis Approximately 7 6 cm (3 in) of asphalt and 20 3cm (8 in) of artificial fill material overlie the natural soil at the 903 Pad Soils will be continuously cored to either a total depth of 0 92 m (3 0 ft) or 0 31 m (1 0 ft) past the depth where the FIDLER indicates less than 5,000 cpm Samples will be collected at 15 cm (6 in) intervals Borings and core will be checked by engineers tape for total depth and recovery If necessary the borings will be overdrilled to a depth of 1 2 m (4 ft) to ensure recovery of the suspected contamination interval from 30 5 cm (12 in) to 61 cm (24 in) Samples for radiological screening will be collected from the top 2 5 cm (1 in) of the 15 cm (6 in) sample The samples will be screened for alpha, beta/gamma, and VOCs using portable field instruments If VOCs are detected above 10 parts per million by field instrumentation at any sampling location, the VOC subsurface soil sampling program, as described in Section 3 2, will be implemented to characterize contamination at that location

Subsurface soil samples for radiochemical analysis will also be collected for the VOC subsurface investigation as described in Section 3 2 Soil samples will be collected from 12 initial and approximately eight "step-out" boreholes on the 903 Pad and one borehole east of well 07191 in the Lip Area Figure 3 4 presents the location of the VOC investigation boreholes Soil samples for radiochemical analysis will be collected immediately above the interval where the VOC sample is collected

Lip Area - A total of twenty-five boreholes are proposed to be completed over the Lip Area where artificial fill was placed in 1970 and where surface soils were remediated in 1976, 1978, and 1984 A systemic grid design for sampling the area was chosen as discussed in Section 2 6 Some judgment was used for grid placement, for the purpose of biasing selected nodes within previous soil removal areas Of the 25 borings, one boring will be completed in the 1976 remediation area, four borings will be completed in the 1978 remediation area, and three borings placed in the proximity of the 1984 remediation area Up to six additional boreholes may be placed as necessary to complete the grid based on analytical results equal to or greater than Tier I soil action levels

This sampling program, a systematic grid design, was spaced and superimposed over the area to collect samples of the artificial fill as well as the natural soil underlying the fill material based on the grid (Figure 3 3) Portions of surface soil plots PT015, TP016, PT019, PT020, PT028, and PT029 are located within the Lip Area Portions of the 903 Pad are located in Plots PT015, PT016, PT019, PT020 which will be characterized under the 903 Pad subsurface radiological investigation

Soil borings located in the Lip Area and subsurface soil samples will be collected utilizing Geoprobe® or conventional hollow-stem auguring techniques Soils will be continuously cored to either a total depth of 0 61 m (2 ft) or 0 31 m (1 ft) past the depth where the FIDLER indicates less than 5,000 cpm, which ever is greater Samples will be collected at 15 cm (6 in) intervals Borings and core will be checked by engineers tape for total depth and recovery If necessary the borings will be overdrilled to a depth of 0 9 m (3 ft) to ensure recovery of the suspected contamination interval from 15 25 cm (6 in) to 30 5 cm (12 in) Samples for radiological screening will be collected from the top 2 5 cm (1 in) of the 15 cm (6 in) sample The samples will be screened for alpha, beta/gamma, and VOCs using portable field instruments Radiological contamination is suspected from ground surface to a depth of 28 cm (11 in) based on the radiological results from Soil Profile Pit TR08

It should be noted that if subsurface soils in the Lip Area are determined to exceed Tier I soil action levels in areas where artificial has been placed, surface soils will be assumed (for alternative analysis purposes) to also be contaminated and will require the same remedial treatment as the subsurface soils This assumption is based on operation difficulties associated with the removal of the surface soils without introducing subsurface contaminants to them, and the probability that the surface soils in the Lip Area have been impacted by radionuclides Detailed surface soil characterization (i e , HPGe surveys) will not be performed in portions of the Lip Area where subsurface soils are determined to exist above Tier I action levels

Americium Zone - Subsurface soil samples will be collected in the Americium Zone to determine the depth of radiological contamination associated with the surface soil program The number, location, and depth of subsurface soil samples to be collected will be determined following the analysis of the HPGe survey data The analysis of HPGe data will provide the areal extent of surface soils exceeding Tier I soil action levels Subsurface soil samples may not be required on the basis of existing data indicating the vertical extent, estimated at 28 cm (11 in) from the OU2 data (DOE, 1995a) If required, additional subsurface soil samples in the Americium Zone may be collected using a similar systematic sampling grid and methodology as used for the Lip Area or another applicable methodology and this SAP will be modified as appropriate

3 2 VOC Investigation

Investigation of VOC contamination at the 903 Pad will begin with the highest areas of groundwater contamination and in the Lip Area where the anomalous PCE soil gas results, east of borehole 07191, were observed Figure 3 4 shows the proposed borehole locations for the VOC investigation Table 3 4 provides the proposed number of boreholes to be completed and the number of samples to be collected by area Table 3 5 provides the analytical program for subsurface soil samples collected for the VOC investigation

Subsurface soil sampling at the 903 Pad will be implemented near existing groundwater monitoring wells 06691, and 08891 using an upgradient radial placement geometry with the well location serving as the downgradient location Boreholes will be located 20 ft to the north, south, and west of well locations 06691, and 08891 Six boreholes will be placed along the west to northwest side of the 903 Pad on the basis of aerial photographs with drum storage and surface staining (Figure 3 4) These locations will utilize the same grid spacing/locations from the subsurface radiological investigation from Figure 3 3 The number of boreholes required to investigate the VOC contamination at the 903 Pad are based on the initial 12 boreholes Approximately eight additional “step-out” boreholes may be required to characterize contamination at the 903 Pad

The soil gas anomaly in the Lip Area at the southeast corner of the 903 Pad adjacent to borehole 07191 will be evaluated One borehole will be spotted with a center 20 ft east and 10 ft south of borehole location 07191 VOC contamination was not detected in subsurface soil samples from borehole 07191

Boreholes will be advanced from the ground or asphalt surface either to a depth of 0 31 to 0 62 m (1 to 2 feet) below the top of bedrock or 0 31 to 0 62 m (1 to 2 feet) below the vertical extent of VOC contamination (based on field instruments) Samples will be collected at 1 22 m (4 ft) intervals below ground surface, or at intervals where VOCs are detected with field instrumentation Because of the different ionization potential between PCE and CCl_4, two photoionization detectors will be used (10 4 and a 11 7 eV bulb) If VOCs are detected above 10 % of the RFCA Tier I action levels, then the sampling grid will be extended an additional 6 1 m

(20 ft) ın an upgradıent dırectıon of that locatıon, and addıtıonal samples wıll be collected for laboratory analysıs

If DNAPL ıs encountered, the follow-up borıng step-out dıstance wıll be reduced to 3 m (10 ft) If DNAPL ıs suspected, an attempt to collect a lıquıd sample from the core barrel wıll be made and the borehole wıll proceed no more than approxımately 0 61 m (2 ft) ınto bedrock Thıs process wıll contınue untıl the area of contamınatıon ıs defined Follow-up borehole locatıons wıll be relocated ın the fıeld based on analytıcal results (ı e ıf areas of VOC contamınatıon are observed as compared to the RFCA Tıer I actıon levels, addıtıonal borehole locatıons for soıl samplıng may be requıred to further delıneate the extent of contamınatıon)

3 3 Sample/Data Collectıon and Handlıng

Prıor to ımplementatıon of the fıeld program, Envıronmental Approval Process for Constructıon/Excavatıon Actıvıtıes (1-F20-ER-EMR-EM 001) wıll be completed Informatıon collected ın the fıeld wıll be recorded ın the field logbook per ADM 05 14, Use of Fıeld Logbooks and Forms and FO 14, Fıeld Data Management

3 3 1 <u>Sample and Data Collectıon</u>

Surface Soıls - HPGe measurements wıll be made at each survey locatıon ın accordance wıth Radıologıcal Engıneerıng Procedures FIDLER surveys wıll be conducted ın accordance wıth ROI Manual, 4-H58-ROI-06 6, Use of Bıcron FIDLER Surface soıl samples wıll be collected utılızıng the RF method, as modıfıed by thıs SAP (Sectıon 3 1 1), ıdentıfıed ın GT 08, Surface Soıl Samplıng

Subsurface Soıls - The vertıcal extent of contamınatıon shall be ınvestıgated through the completıon of boreholes Borehole locatıons shall be cleared accordıng to GT 10, Borehole Clearıng Boreholes wıll be completed by procedure GT 02, Drıllıng and Samplıng Usıng Hollow-Stem Auger Technıques, or by GT 39, Push Subsurface Soıl Sample If hollow-stem auger technıques are selected, soıl samples wıll be collected utılızıng eıther contınuous core auger samplıng or contınuous drıve samplıng, dependıng on whıch method provıdes the best percentage of core recovery Soıl cores wıll be screened wıth field ınstruments per FO 15, Photoıonızatıon Detectors and Flame Ionızatıon Detectors Boreholes wıll be logged accordıng to procedure GT 01, Loggıng Alluvıal and Bedrock Materıal Boreholes wıll be abandoned by procedure GT 05, Plugging and Abandonment of Boreholes, except that geoprobe boreholes will be backfilled with powdered or granular bentonite from ground surface and not tremmied Boring locations will be identified with their unique location number assigned and surveyed for location and elevation using GPS receivers or equivalent equipment

3 3 2 Sample Handling

The location and depth interval of surface or subsurface media, either soil or water, recovered during the course of this investigation will be recorded in the field log book RFEDS location codes will be cross indexed to appropriate sample location designations in the field logbook Soil core and other material that is subject to only field screening will be identified by the sample location code and depth interval where the sample is obtained Samples undergoing VOC or radioisotope analysis will have RFEDS sample numbers applied to the container labels in the field The numbers will be applied sequentially as the samples are collected and the COC form is prepared A block of sample numbers will be obtained from the RFEDS A block of location codes and sample numbers will be of sufficient size to include the entire number of possible locations and samples scheduled for analysis and an additional twenty percent for potential additional locations and samples The RFEDS sample numbers will be cross referenced with the Kaiser Hill-Analytical Services Division (KH-ASD) sample numbers Data record storage will be performed by KH-ASD Sample collection and handling will follow procedure 5-21000-OPS-FO 13, Containerization, Preserving, Handling, and Shipping Soil and Water Samples Samples will be transported to laboratories accordance with FO 25, Shipment of Radioactive Materials Samples

3.4 Equipment Decontamination/Waste Handling

Reusable sampling equipment will be decontaminated in accordance with procedure FO 03, Field Decontamination Procedures Decontamination waters generated during the project will be managed according to procedure FO 07, Handling of Decontamination Water and Wash Water Drilling equipment will be decontaminated between IHSSs using procedure FO 04, Decontamination of Equipment at Decontamination Facilities

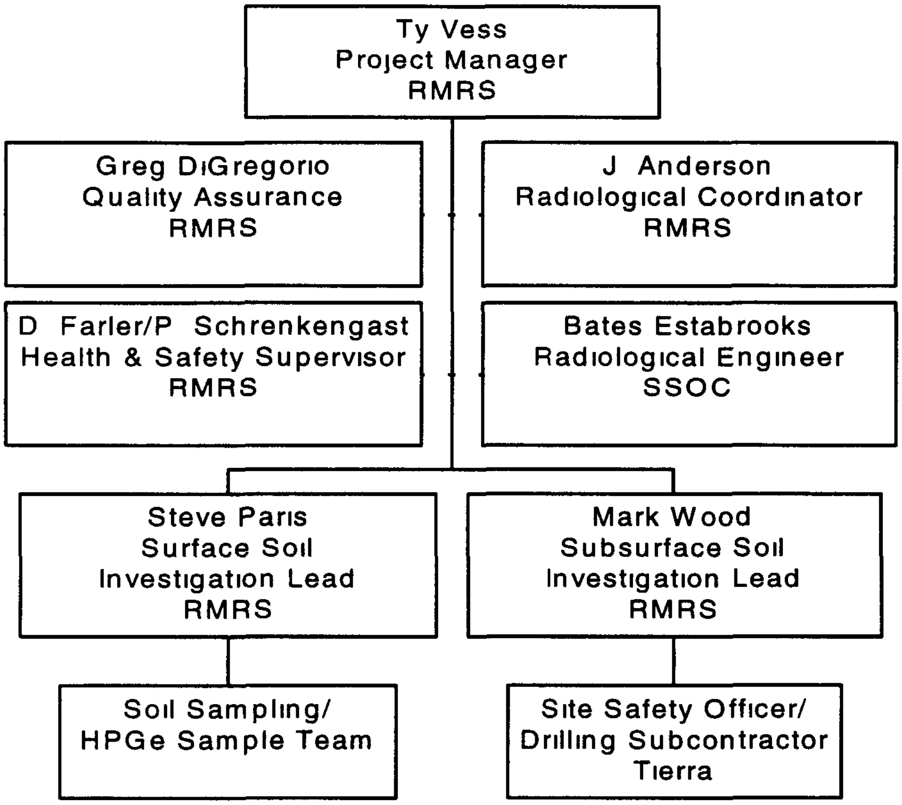
Drill cuttings will be handled in accordance with FO 08, Handling and Containerizing Drilling Fluids and Cuttings Returned sample media will be managed in accordance with FO 09, Handling of Residual Samples Containers will be labeled in compliance with FO 10, Receiving, Marking and Labeling Environmental Containers Waste containers will be managed by procedure FO 23, Management of Soil and Sediment Investigative Derived Materials (IDM) and FO 29, Disposition of Soil and Sediment Investigation-Derived Materials Personal protective equipment shall be disposed according to procedure FO 06, Handling of Personal Protective Equipment In the event that hazardous, low level, or mixed wastes are generated project waste generators will be responsible for insuring that the waste containers are properly filled, labeled, and have the waste residue traveler documentation in accordance with plant procedures (1-C88-WP1027-NONRAD, "Non-Radioactive Waste Packaging", 1-M12-WO4034, "Radioactive Waste Packaging Requirements", 4-099-WO-1100, "Solid Radioactive Waste Packaging", 1-C80-WO-1102-WRT, "Waste/Residue Traveler Instructions", and the WSRIC for Operable Unit Operations, "Version 6 0, Section No 1, PADC-96-00003)

4.0 PROJECT ORGANIZATION

Figure 4 1 illustrates the project organizational structure The RMRS Environmental Restoration Projects Group project manager will be the primary point of responsibility for maintaining data collection and management methods that are consistent with site operations Other organizations assisting with the implementation of this project are RMRS Groundwater Operations, RMRS Health and Safety, RMRS Quality Assurance, and Safe Sites of Colorado (SSOC) Radiological Engineering, SSOC Radiological Operations, and KH-ASD

The sampling personnel will be responsible for field data collection, documentation, and transfer of samples for analysis Field data collections will include sampling and obtaining screening results Documentation will require detailed field logs and completing appropriate forms for data management and chain-of-custody shipment The sampling crew will coordinate sample shipment for on-site and off-site analyses through the ASD personnel The sampling manager is responsible for verifying that chain-of-custody documents are complete and accurate before the samples are shipped to the analytical laboratories

Figure 4 1
903 Pad, 903 Lip Area, and Americium Zone
Organizational Chart



5.0 QUALITY ASSURANCE

All components and processes within this project will comply with the RMRS Qualify Assurance Program Description RMRS-QAPD-001, 1/1/97 which is consistent with the K-H Team QA Program (K-H, 1997) The RMRS QA Program is consistent with quality requirements and guidelines mandated by the EPA, CDPHE and DOE In general, the applicable categories of quality control are as follows

- Quality Program
- Training,
- Quality Improvement,
- Documents/Records,

- Work Processes,
- Design,
- Procurement,
- Inspection/Acceptance Testing,
- Management Assessments, and
- Independent Assessments

The project manager will be in direct contact with QA to identify and correct issues with potential quality affecting issues Field sampling quality control will be conducted to ensure that data generated from all samples collected in the field for laboratory analysis represent the actual conditions in the field The confidence levels of the data will be maintained as described in Section 2 0 by the collection of QC and duplicate samples, equipment rinsate samples, and trip blanks

Duplicate samples will be collected on a frequency of one duplicate sample for every twenty real samples Rinsate samples will be generated at a frequency of one rinsate sample for every 20 real samples collected Trip blanks will accompany each shipment of VOC samples generated for the project Trip blanks will not be required for samples shipped for radiochemical analysis only Data validation will be performed on 25% of the laboratory data according to the Rocky Flats ASD, Performance Assurance Group procedures Samples will be randomly selected from adequate surface and subsurface sample sets (RINS) by ASD personnel to fulfill data validation of 25% of the total number of VOC and radioisotopic analyses Table 5 1 provides the QA/QC samples and frequency requirements of QA sample generation

Table 5 1 QA/QC Sample Type, Frequency, and Quantity

Sample Type	Frequency	Comments	Quantity (estimated)
Duplicate	One duplicate for each twenty real samples		25
Rinse Blank	One rinse blank for each twenty real samples	To be performed with reusable sampling equipment following decontamination procedures	25
Trip Blank	One trip blank per shipping container	VOC analysis shipments only	25

Analytical data that is collected in support of the of the 903 Pad SAP will be evaluated using the guidance developed by the Rocky Flats Administrative Procedure 2-G32-ER-ADM-08 02, Evaluation of ERM Data for Usability in Final Reports This procedure establishes the guidelines for evaluating analytical data with respect to precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters

A definition of PARCC parameters and the specific applications to the investigation are as follows

Precision - A quantitative measure of data quality that refers to the reproducibility or degree of agreement among replicate or duplicate measurements of a parameter The closer the numerical values of the measurements are to each other, the lower the relative percent difference and the greater the precision The relative percent difference (RPD) for results of duplicate and replicate samples will be tabulated according to matrix and analytical suites to compare for compliance with established precision DQOs Specifications on repeatability are provided in Table 5 2 Deficiencies will be noted and qualified, if required

Accuracy- A quantitative measure of data quality that refers to the degree of difference between measured or calculated values and the true value of a parameter The closer the measurement to the true value, the more accurate the measurement The actual analytical method and detection limits will be compared with the required analytical method and detection limits for VOCs and radionuclides to assess the DQO compliance for accuracy Sensitivities of analytical and radiochemical methods scheduled are listed in Tables 2 1 and 2 2

Representativeness - A qualitative characteristic of data quality defined by the degree to which the data absolutely and exactly represent the characteristics of a population Representativeness is accomplished by obtaining an adequate number of samples from appropriate spatial locations within the medium of interest The actual sample types and quantities will be compared with those stated in the SAP or other related documents and organized by media type and analytical suite Deviation from the required and actual parameters will be justified

Completeness - A quantitative measure of data quality expressed as the percentage of valid or acceptable data obtained from a measurement system A completeness goal of 90% has been set for this SAP Real samples and QC samples will be reviewed for the data usability and achievement of internal DQO usability goals If sample data cannot be used, the non-compliance will be justified, as required

Comparability - A qualitative measure defined by the confidence with which one data set can be compared to another Comparability will be attained through consistent use of industry standards (e g , SW-846) and standard operating procedures, both in the field and in laboratories Statistical tests may be used for quantitative comparison between sample sets (populations) Deficiencies will be qualified, as required Quantitative values for PARCC parameters for the project are provide in Table 5 2

Laboratory validation shall be performed on 25% of the characterization data collected in support of this project Laboratory verification shall be performed on the remaining 75% of the data Data usability shall be performed on laboratory validated data according to procedure 2-G32-ER-ADM-08 02, Evaluation of ERM Data for Usability in Final Reports

Table 5 2 PARCC Parameter Summary

PARCC	Radionuclides	Non-Radionuclides
Precision	Duplicate Error Ratio ≤ 1 42	RPD ≤ 30% for Organics RPD ≤ 40% for Non-Organics
Accuracy	Detection Limits per method and APO Laboratory SOW HPGe Detection limits per Technical Basis Document and per SAP	Comparison of Laboratory Control Sample Results with Real Sample Results
Representativeness	Based on SOPs and SAP	Based on SOPs and SAP
Comparability	Based on SOPs and SAP	Based on SOPs and SAP
Completeness	90% Useable	90% Useable

6.0 SCHEDULE

Subsurface soil field activities are scheduled to begin in February with an expected completion in late April 1998 Surface soil field activities are scheduled to begin in February with an expected completion in late May to early June 1998 A data summary report is expected to be completed by August 1998

7.0 REFERENCES

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Sampling and Analysis Plan
for the
Site Characterization of the 903 Drum Storage Site
903 Lip Area, and Americium Zone

Responses to Agency Comments

December 15, 1997

D /aag/903pad98/eparesp4

Comment 1A

Page 1, Sectıon 1 0, Paragraph 2, last sentence This sentence states that characterızatıon of surface soıl contamınatıon wıll be done over an exposure area of 1,217 square feet Please provıde the ratıonale for selectıon of thıs sıze area

Response

Trıpod mounted ın-sıtu gamma-ray spectroscopy systems posıtıoned wıth a detector heıght of 1 m (3 28 ft) measure areas wıth a FOV of 12 m (39 4 ft) dıameter cırcle (1,217 ft^2) Thus the EA has been defined to be sıngle HPGe measurement wıth a FOV of 12 m (39 4 ft) ın dıameter Thıs cırcular area represents 1,217 ft^2 or 2 8 x 10^{2} acre

Comment 1B

Sectıon 1 0 also states that revısıons to the SAP may be warranted due to the Actınıde Mıgratıon Study We concur wıth thıs statement Factors other than the results of thıs study may also affect the actıon levels that drıve thıs project and therefore potentıally requıre revısıons to the samplıng plan

Response

We agree However, ın order to proceed wıth the project we have to make assumptıons based on Best Applıcable Technology The ınsıtu gamma-ray spectroscopy usıng HPGe ıs the best avaılable technology to effıcıently evaluate surface soıl contamınatıon ın the Investıgatıon Area We wıll proceed wıth the HPGe ınvestıgatıon untıl two consecutıve FOVs are less than or equal to 10 pCı/g Am-241 based on ınput from the Actınıde Mıgratıon Panel

Comment 2

Page 4, Sectıon 1 2 1, first sentence Thıs states that HPGe surveys conducted ın 1990 and 1994 provıded "useful" ınformatıon on the actıvıty of Am-241 , however the paragraph goes on to say that soıl samples were not collect to supplement the surveys Please provıde us wıth the ınformatıon that verıfies thıs ınformatıon to be useful ıf soıl analysıs were not performed

Response

We have revısed the text to more clearly state the ratıonal of our ınvestıgatıon The 1990 and 1994 HPGe data were one source of data used to delıneate the extent of surface soıls Investıgatıon Area as presented ın Fıgure 1 2 of the revısed SAP The HPGe data from these two ınvestıgatıons were used to extend the study area ınto areas where RFI/RI surface soıl samplıng results dıd not exceed Tıer I actıon levels It was determıned that ıf an HPGe measurement ın excess of 10 pCı/g Am-241 was detected wıthın a portıon of a RFI/RI surface soıl plot that portıon of the plot would be selected for ınclusıon ın the Investıgatıon Area Surface soıl plots PT035, PT045, PT047, PT048, PT054, PT055, PT062 were ıncluded wıthın the Investıgatıon Area based on thıs ratıonal

Comment 3

Page 7, Sectıon 1 2 3 Thıs sectıon dıscusses groundwater monıtorıng wells These wells are located on Fıgure 3-4, however, a reference and orıentatıon to that map would be useful ın thıs paragraph

Response

We have revısed the text to ınclude a reference to Fıgure 1 2 and 3 4

Comment 4A

Page 8, Sectıon 1 3, paragraph 3 sentence 3 Thıs sectıon states that several areas outsıde of the 903 Pad and Lıp Area show hıgher Pu and Am actıvıtıes than ınsıde the 903 Pad Please justıfy why your samplıng grıd ıs less ıntensıve ın these area for radıonuclıdes based on thıs ınformatıon

Response

It ıs ımportant to note that thıs paragraph references surface soıl contamınatıon The Amerıcıum Zone comprıses areas outsıde the 903 Pad and Lıp Area wıthın the project's Study Area (Fıgure 1 1) The Amerıcıum Zone surface soıls shows areas wıth greater actıvıtıes than areas ınsıde the Lıp Area because a portıon of the Lıp Area's surface soıls have been covered wıth artıficıal fill The 903 Pad has been covered wıth artıficıal fill and an asphalt cap The Amerıcıum Zone ıs not a source area but an area where contamınatıon was deposıted durıng resuspensıon of contamınated soıls from the 903 Pad and Lıp Area

The SAP proposes a progressive investigation including both HPGe measurements and subsurface soil samples to be collected in the Americium Zone The HPGe measurements will determine the surface area exceeding the Tier I action levels Boreholes will be completed within this area to determine the depth of contamination and for calculating the volume of soil exceeding Tier I action levels The number and location of boreholes will be based on extent of surface soil contamination determined by the HPGe measurements that exceed Tier I soil action levels The HPGe measurement grid was originally selected to provide 100% of the study area (as identified in the previous version of the SAP), but was revised to provide 74% coverage (See response to Comment 7) A 74% areal coverage is much more thorough than any comparable soil grab sampling at individual points After the surface area exceeding Tier I soil action levels is determined in the Americium Zone by HPGe, a grid will be designed and the number of boreholes will be calculated to ensure that coverage of subsurface soil volumes is above a specified confidence limit The SAP will be modified to include the Americium Zone subsurface sampling program following the analysis of the HPGe survey

Comment 4B

The third paragraph also describes the surfical soil contamination being atypical of wind disbursement which produces an evenly decreasing distribution, but rather a distribution which includes hot spots Please provide the rationale for the proposed sampling grids which describes how these distributions have been taken into consideration Should the sampling patterns be regularly spaced, randomly chosen, or biased? Do surface features (slope, drainage, precipitation, concentrations at the edge of the asphalt need to be considered? Please address these concerns

Response

This paragraph references surface soil contamination The Americium Zone surface soils show greater activities than areas inside the Lip Area because the Lip Area surface soils have been covered with artificial fill

Contamination distribution patterns were reevaluated by the project staff based on actinide distribution maps presented in the *Summary of Existing Data on Actinide Migration at the Rocky Flats Environmental Technology Site* (DOE, 1997) Surface soil isoconcentration contours for americium-241 provided in Figure 4-1and plutonium-239/240 provided in Figure 4-2 of the data summary show elevated activities nearer the 903 Pad with decreasing activities moving eastward However, the two isolated plutonium-239/240 areas (above 1,000 pCi/g) are present in RFI/RI Plots PT035 and PT046 These plots were identified from results from the RF sampling method The RF sampling method includes the compositing of 10 grab samples to two inches in depth at the corners and center of two one-meter square grid separated by one square meter The sample represents the physical average of activity in soils over a three square meter area These plots were also sampled using the CHD surface soil sampling method The CDH sampling method included the collection of 25 grab samples to a depth of 0 64 cm over the entire 2 5- or 10-acre plot (2 5-acre plot in this case) The CHD sample results represent the physical average of activity over the 2 5-acre plot and the sum of ratios of these results did exceed Tier I soil action levels This indicates that only a portion of the plot may exceeds action levels and that the area may be isolated indicative of a radiological "hot spot"

Please provide the rationale for the proposed sampling grids which describes how these distributions have been taken into consideration

The proposed surface soil sampling program is based on a progressive investigation including the collection of HPGe measurements beginning at the western edge of the Americium Zone (adjacent to the 903 Lip Area) The HPGe investigation will begin in the Americium Zone because if the Lip Area subsurface investigation determines subsurface soils exceed the Tier I action levels it is assumed that the surface soils will require the same action as the subsurface soils and therefore not require additional characterization HPGe measurements will be continuously collected in a eastward direction beginning in the Americium zone until two consecutive measurements are recorded below the 10 pCi/g Am-241 decision level Two consecutive readings represents a linear distance of 78 8 feet Two consecutive measurements below the 10 pCi/g Am-241 decision level will ensure that the investigation has determined the boundary of soil contamination

Should the sampling patterns be regularly spaced, randomly chosen, or biased?

Response
Systematic grid sampling is the primary method of choice for subsurface radionuclide samples based on rationale added to Section 2 0, where it is explained that systematic grid sampling is consistent with the objectives of the project Asphalt samples for radionuclides will be randomly taken from the systematic grid, these are random because no prior data exists to characterized asphalt for contamination or related distributions Subsurface sampling design in the Americium Zone is dependent on the surficial sample results, and has not yet been designed

All VOC sample placement is based on a subjective, or "judgment", sampling design given the valid historical data All areas of interest are completely accessible so that location bias is not a problem, the locations were chosen for their unique value and representation rather than for drawing inferences about a wider population

Subsurface soil sampling locations will be based on data collected from the HPGe surface soil investigation The HPGe survey measurements will determine the surface area exceeding the Tier I action levels Boreholes will be completed within this area to determine the depth of contamination for calculating the volume of soil exceeding Tier I action levels The number and location of boreholes will be based on extent of surface soil contamination exceeding Tier I soil action levels After the surface area exceeding Tier I soil action levels is determined, a grid will be designed and the number of boreholes will be calculated to ensure the area is adequately characterized to determine the volume of soils with a specified confidence limit

Do surface features (slope, drainage, precipitation, concentrations at the edge of the asphalt) need to be considered?

Response
Surface features definitely need to be considered for the characterization of radiological contamination within the study area This is evident from the shape and location of the area requiring remediation in 1978 This remediation area is located on the slope break between the pediment surface and the hillside leading down to Walnut Creek It is evident that contamination collected in areas represented by this topographic feature due to protection of the area from wind The slope break areas will investigated by HPGe measurements In addition, areas suspected to be have been subjected to recent erosion and deposition activities will be investigated These areas include the drainage channel parallel to the windrow at the eastern edge of the Lip Area, and surface soils at the output of the culvert draining the area Soils at the edge of the 903 Pad are suspected to be artificial fill Surface soils in these areas will be investigated if the subsurface soil investigation results indicate that natural soils (underlying the artificial fill) in these areas do not exceed Tier I soil action levels

Comment 5
Page 9, Section 1 3 The fourth paragraph identifies subsurface soil contaminants of concern The source of this information should be cited

Response
The text has been revised with the appropriate references cited

Comment 6A
Page 13, first set of bullets This section describes information to be gathered, however, there was no mention of the extent of contamination or organics outside the 903 Pad area, although Table 3 3 includes VOC boreholes in the Lip area (section 1 2 3 states that a VOC contaminated groundwater plume exists from the 903 Pad area to the east) There also was no mention of characterization of the artificial fill material Please include this or provide rationale for its exclusion

Response
The text has been clarified as follows regarding the VOC subsurface investigation A VOC-contaminated groundwater plume originates from the 903 Pad area and extends to the east The highest concentrations of VOCs are found in groundwater samples collected from wells 06691 and 08891 located on the asphalt portion of the 903 Pad (see Figures1 2 and 3 4 for well locations) Concentrations of VOCs in groundwater decrease rapidly moving

eastward from the 903 Pad area This decrease ın concentratıon may be a result of the hydraulıc dıspersıvıty reflected ın the dıstance between the two wells and downgradıent well locatıons

The extent of VOC contamınatıon equal to or above Tıer I soıl actıon levels ın subsurface soıls at the 903 Pad and the area southeast of the 903 Pad based on sıte hıstory The source of the groundwater plume ıs the 903 Pad and possıbly the soıl gas anomaly east of borıng 07191 based on surfıcıal staınıng and sıte use for drum storage

Artıfıcıal fill ıs not consıdered a source for VOC contamınatıon, however, the artıfıcıal fill wıll be evaluated for radıologıcal contamınatıon durıng the ımplementatıon of the subsurface radıologıcal ınvestıgatıon of the 903 Pad and Lıp Area Subsurface samplıng at 6-ınch ıntervals to a depth of 2 feet on the 903 Pad and to a depth of 3 feet ın the Lıp Area wıll suffıcıently characterıze the artıfıcıal fill materıal overlyıng natıve materıal

Comment 6B
Sectıon 2 4, Surface Soıls A standard of 10 pCı/g ıs used for a crıterıa ın analyzıng presence of Am-241 Please provıde justıfıcatıon for usıng thıs concentratıon

Response
Thıs sectıon dıscusses the selectıon of the formerly referenced Study Area, revısed to Investıgatıon Area The 1990 and 1994 HPGe data were one source of data used to delıneate the extent of surface soıls study area as presented ın Fıgure 2 1 ın the former revısıon SAP (Fıgure 1 2 ın thıs revısıon of the SAP) The HPGe data from these two ınvestıgatıons were used to extend the study area ınto areas where RFI/RI surface soıl samplıng results dıd not exceed Tıer I actıon levels It was determıned that ıf an HPGe measurement ın excess of 10 pCı/g Am-241 was detected wıthın a portıon of a RFI/RI surface soıl plot the entıre plot would be selected for ınclusıon ın the study area The 10 pCı/g Am-241 represents approxımately one-tenth the Am-241 actıvıty requıred to trıgger a Tıer I soıl actıon level exceedance Surface soıl plots PT035, PT045, PT047, PT048, PT054, PT055, PT062 were ıncluded wıthın the Investıgatıon Area based on thıs ratıonal

Comment 7.
Fıgure 2-1, Surface Soıls Thıs fıgure lısts varıous ınformatıon, however, no values are gıven specıfıc to the HPGe survey Please, at a mınımum ınclude the HPGe values ın the fıgure, depıct the Amerıcıum Zone more clearly ın thıs fıgure and all remaınıng fıgures Also ıt ıs noted that scalloped areas form from the HPGe survey whıch may lead to areas whıch are not thoroughly surveyed Please address thıs problem

Response
The fıgure has been revısed and renumber (Fıgure 1 3 of the revısed SAP) to ınclude HPGe measurement values for each fıeld of vıew provıded on the map The 903 Pad, 903 Lıp Area, and Amerıcıum Zone wıll be labeled on maps Revısıon to thıs SAP propose to complete HPGe measurements over 74% of the Investıgatıon Area untıl two consecutıve and adjacent measurements are below the 10 pCı/g Am-241 decısıon level Therefore, any scalloped areas of the HPGe FOV wıll be ın areas below the decısıon level and no longer requırıng characterızatıon The 74% coverage was calculated based on a grıd spacıng equal to the FOV of the measurement Based on thıs grıd spacıng FOVs wıll be adjacent to one another (no overlap) and an unsurveyed dıamond-shaped ınterstıce wıll be present between four adjacent FOV (see Fıgure 3 1) The unsurveyed areas ın the proposed grıd represent 26% of the total surveyed area Thıs coverage ıs acceptable based on the followıng assumptıons 1) the unsurveyed ınterstıce wıll be assumed to exceed Tıer I actıon levels ın the event ıt ıs adjacent to any FOV whıch ıs determıned to exceed Tıer I actıon levels, 2) The goal of the SAP ıs to estımate the volume of soıls exceedıng Tıer I actıon levels for ınput ınto a remedıal alternatıve analysıs portıon of an IM/IRA or PAM Based on the samplıng grıd no ınterstıces areas at the boundary wıll be ıncluded ınto the volume estımate, therefore, a mınımal overestımate of the soıl volume to be remedıated wıll be calculated

Comment 8A
Page 17, Table 2 2 Thıs table lısts the Tıer I actıon level for Carbon Tetrachlorıde to be 110 mg/kg It should be stated as 11 mg/kg

Response
The table has been revısed to reflect the correct RFCA Tıer I soıl actıon level for carbon tetrachlorıde at 11 mg/kg

Comment 8B

Asphalt Section, last sentence This sentence states that "If radionuclides above background are present in the asphalt is must be managed as radioactive waste material" Please provide the values you will use as background, i e soils background or asphalt background?

Response

The text has been revised The decisions to be made on the asphalt are do the sample variance and mean values calculated from sample results sufficient to determine the appropriate number of samples required to adequately characterize the 903 Pad asphalt to meet a waste disposal facilities Waste Acceptance Criteria (WAC) Inputs to the decision include radiochemical data for Am^{241}, $Pu^{239/240}$, uranium-233/234 ($U^{233/234}$), uranium-235 (U^{235}), and uranium-238 (U^{238}) to be used for comparison to the WAC requirements and not for comparison to background values

Comment 9A

Page 18, Surface Soil Section and Page 19, Radiological Investigation Spatial Section Please provide further information concerning the HPGe surveys to include details of how back calculation will be performed in the field, what the cut-off screening levels will be for Tier I, what isotopes will be calibrated to, what type of distribution you are assuming the data to be,, whether the comparison values are instrument dependent, number of samples that will be collected to verify correlation, and the rationale as to how you can verify that the ratio will be consistent from the HPGe with actual soil analysis, especially for subsurface soils

How will back calculation will be performed in the field?

Response

Processing of HPGe measurement data will not be conducted in the field The processing will be conducted by project personnel in an office setting The results of the HPGe measurements will be communicated daily to project supervisors where the data will be input into the sum of ratios equation for a Tier I action level comparison Field personnel will be provided measurement location assignments based on the results of previous measurements

What will be the cut-off screening levels will be for Tier I?

Response

HPGe measurements will be performed beginning at the western boundary of the Americium Zone and continue eastward until the two consecutive and adjacent measurements below the 10 pCi/g Am-241 decision level are reached When two consecutive and adjacent measurements below the 10 pCi/g Am-241 decision level is reached in any direction (east-west, north-south, diagonal) HPGe measurements will no longer be required

What isotopes will be calibrated to?

Response

The Technical Basis Document, In Situ Gamma-Ray Spectrometry for the Measurement of Uranium and Plutonium in Environmental and Solid Matrices, Rev 0 , provides a description and technical justification for the use of in situ gamma ray spectrometry in characterization and remedial tasks at the RFETS Section 2 1, Detector Characterization and the Calculation of Conversion Factors for Extended Areas, states

> The detector characterization is accomplished by measuring the detector sensitivity to a number of gamma-ray energies at angles ranging from 0-90 degrees The single nuclide sources used to perform the characterization are typically traceable to the US Department of Commerce, National Institute of Standards and Technology for activity The energy emissions of these sources must span the full range of energies which will be required in the measurements The sources typically selected are Am-241, Cesium-137, Colbalt-60 and Europium-152 The useful gamma ray emissions from these sources range from 32 1 keV to 1408 0 keV

What type of dıstrıbutıon you are assumıng the data to be?

Response
Based on hıstorıcal data at the RFETS, both radıonuclıdes and VOCs are lognormally dıstrıbuted ın soıls

Whether the comparıson values are ınstrument dependent?

Response Values to be compared ınclude the HPGe measurement results and soıl analytıcal results It ıs assumed the questıon ıs ın regard to HPGe measurement values The HPGe detectors wıll be routınely characterızed prıor to ımplementatıon ınto the field The characterızatıon of detectors wıll mınımıze any varıabılıty between ınstrumentatıon and measurements collected ın the field

Number of samples that wıll be collected to verıfy correlatıon?

Response
A mınımum of 15 surface soıl results wıll be correlated to HPGe measurements Sectıon 3 1 1 provıdes a detaıled descrıptıon and methodology as to sample locatıon and collectıon

The ratıonale as to how you can verıfy that the ratıo wıll be consıstent from the HPGe wıth actual soıl analysıs, especıally for subsurface soıls

Response
The ratıo of Pu-239/240 to Am-241wıll be determıned from lınear regressıon analysıs of HPGe Am-241 results on Pu-239/240 soıl results collected ın support of thıs SAP The slope of the regressıon lıne (ı e Pu-239/240 to Am-241 ratıo) wıll be compared to exıstıng Pu-239/240 to Am-241 ratıos at the Sıte (5 -7) In sıtu HPGe measurements wıll be conducted on surface soıls only Subsurface soıl samples wıll be analyzed by alpha spectroscopy

Comment 9C
Subsurface Soıl Sectıon An 80-foot grıd pattern ıs chosen for characterızatıon purposes Please provıde the ratıonale for the selectıon of thıs sıze area

Response
Explanatıon of the grıd pattern has been augmented ın Sectıon 2 0 wıth respect to decısıon error The grıd pattern and densıty are a functıon of project fundıng lımıtatıons, number of samples for adequate confidence relatıve to RFCA Tıer I actıon levels, and bıasıng of the grıd locatıons to specıfic areas of ınterests

Comment 9D.
The grıd proposes 25 boreholes to cover the 903 Pad Thıs grıd potentıally allows for sıxteen 90 foot dıameter hot spots Assumıng there are such hot spots under the Pad, a 10% chance of mıssıng one means there ıs a near certaınly of mıssıng 1 or 2 wıth such a grıd Thıs ıs only acceptable ıf the actual decısıon document wıll ınclude performance verıficatıon samplıng on a much finer scale

Response·
Sample poınts wıth detectıon's that are adjacent to sample poınts wıth no detectıon's wıll be complemented by an addıtıonal "step-out" samplıng poınt, at half the dıstance between the orıgınal sample poınts Thıs step-out approach wıll double the detectıon resolutıon of the grıd cıted above (from a cırcular dıameter of 82 ft to 41 ft) One step-out ıs planned for each scenarıo descrıbed above, addıtıonal step-outs are not planned, but mıght be feasıble wıthout addıtıonal budget

Comment 10A
Page 19 The first complete sentence states that 25% of data wıll undergo lab valıdatıon Please explaın how the 25% wıll be selected

Response.
Text in Section 5 0 has been revised as follows Samples will be randomly selected from adequate surface and subsurface sample sets (RINS) by Analytical Services Division personnel to fulfill data validation of 25% of the total number of VOC and radioisotopic analyses

Comment 10B
Page 19, Paragraph 1 There is a reference to "a strong linear correlation between americium-241 and plutonium-239/240 in surface soils" This is a critical assumption and should be explained On what specific set of field data is this conclusion based? How large is the data set?

Response
This observation is based on the results of 116 surface soil samples collected over 124 plots from within this study area (Figure 1 1 provides the study area, Figure 1 5 provides the surface soil plots) The samples were collected by compositing 25 subsamples collected over a 2 5- or 10-acre plot using the CDH method (SOP GT 08) Americium and plutonium were analyzed using linear regression technique, the analysis results provided an r^2 of 0 983 This implies that the straight line method relating plutonium-239/240 to americium-241 can explain 98% of the variation present in the sample of americium-241

The correlation was recalculated based on combining the of the two sets OU2 RFI/RI surface soil sampling techniques (CDH and RF) data sets Two hundred and four americium and plutonium sample results were analyzed using linear regression technique, the analysis results provided an r^2 of 0 9596

Comment 10C
Page 19, Paragraph 3 states that 100 pCi/g activity for Am has been selected for the HPGe threshold value How does this value relate to the 10 pCi/g as mentioned in comment No 6? Please explain

Response
The 100 pCi/g Am-241 activity was back calculated from the sum of ratios equation to estimate the maximum Am-241 activity that could be present before 85% of the Tier I Soil action level was exceed Known maximum U-isotopic activities from the study area's previous surface soil investigations were used in the equation, Pu-239/240 activities were estimated at 5 times the Am-241 activity base on previous soil sample results (see response to Comment 10B) Response to Comment 10D further explains the back calculation of the 100 pCi/g Am-241 decision level

In addition, the investigation boundary decision level has been revised to 10 pCi/g Am-241 for the HPGe survey (i e HPGe survey will be conducted until two consecutive HPGe measurements are below the decision level of 10 pCi/g Am-241) This value, recommended by the Actinide Migration Expert Panel, significantly lowers the decision level and will provide the necessary data in the event RFCA soil action levels are also lowered for the protection of surface waters

The 10 pCi/g Am-241 activity referenced in Comment 6 refers to HPGe measurements locations which were included into the Investigation Area Therefore, the values are not related

Comment 10D
Paragraph 3 also describes use of an 85% factor to be applied to the sum of ratios to derive a threshold value Please explain what this is based on Does this factor account for uncertainties such as measurement errors, sampling variability, and uncertainty as to the Am/Pu ratio, etc ?

Response
The response will address the two specific questions

What is the 85% factor based on?

The "85% factor" was the predetermined value (result) for the sum or ratio equation used to determine the HPGe Am-241 threshold (action level) activity

The 100 pCi/g threshold value was back calculated and represents 0 85 of the sum of ratios using RFCA Tier I soil action level The sum of ratio equation is provide below

$$\frac{Am-241}{215}+\frac{Pu-239/240}{1429}+\frac{U-233}{1738}+\frac{U-235}{113}+\frac{U-238}{586}=0\ 85\ \text{Tier I Action Level}$$

The 100 pCi/g Am-241 value was back calculated using the following input parameters

Sum of Ratio Product = 0 85 Tier I Action Level
Plutonium-239 = 5 024 (Am-241) pCi/g
Uranium -233/234 = 6 79 pCi/g
Uranium - 235 = 2 11 pCi/g
Uranium - 238 = 11 94 pCi/g

The plutonium input value represents the mean Pu/Am activity ratio calculated for 116 CDH surface soil samples collected within this investigations Study Area The uranium isotope input value represents the maximum uranium isotope activity detected in 116 surface soil samples and 124 soil profile pit samples collected with this investigations Study Area These values were incorporated into the sums of ratio equation which is provided below

$$\frac{Am-241}{215}+\frac{5\ 024(Am-241)}{1429}+\frac{6\ 79}{1738}+\frac{2\ 11}{113}+\frac{11\ 94}{586}=0\ 85\ \text{Tier I Action Level}$$

Solving the equation for americium-241

Am -241 = 98 9 pCi/g
Rounded to 100 pCi/g

Does this factor account for uncertainties such as measurement errors, sampling variability, and uncertainty as to the Am/Pu ratio, etc ?

Response
Yes However, the decision level has been lowered to 10 pCi/g as discussed in the response to Comment 10C

Comment 11B
Last sentence on page 20, states "Based on this grid a 90 foot diameter hot spot " Please explain where the 90 foot determinant originated from

Response
The diameter of the hot spot was determined from the grid size, hot spot shape, and consumer's risk (Beta error) of not detecting the "hot spot" given the grid spacing and pattern Gilbert (1987, Chapter 10) provides the method by which the hot spot geometry and error were calculated Note that the grid overlay position and spacing has been altered slightly from Revision 0 of the SAP - the grid is slightly denser (from 80 ft to 75 ft), and the grid position was shifted for the purpose of getting more samples in the soil removal areas The grid size input was 80-foot square sampling grid, a circular shaped hot spot, and consumer risk of not hitting the hot spot of 10% Figure 10 3 (page 122) of Statistical Methods for Environmental Pollution Monitoring provides a chart for this determination R O Gilbert 1987 Van Norstrand Reinhold

Comment 12A
Page 21, Paragraph 1, Sentence 1 states that 21 boreholes are proposed to be completed over the Lip Area, however, sentence 3 states that 14 boreholes will be placed at each node of a 165' grid and Figure 3 3 includes 22 samples Please explain this, and provide information to demonstrate this number will be representative

Response
Text was revised in Section 2 6 and Table 2 4 was added to clarify the statistical basis Systematic grid sampling was selected as the design of choice based on one of the primary objectives of this project To estimate, with

quantifiable error, the location(s) and volume of soils that must be remediated due to contaminants (VOCs and radionuclides) that exceed applicable action levels Statistical studies indicate that this approach is preferred over other designs for estimating means, totals, and patterns of contamination (Gilbert, 1987) Further, a systematic grid pattern is essential for quantifying the "consumer's risk" associated with the design, i e , to address the question what is the probability of missing a contaminant of concern (consumer's risk), within the sampling boundaries, with a given size, shape, and concentration? Consumers' risk, within an environmental restoration scenario, may be thought of as the risk assumed by the public (and regulators)

A total of twenty-five boreholes are proposed to be completed over the Lip Area where artificial fill was placed in 1970 and where surface soils were remediated in 1976, 1978, and 1984

Comment 12B
A 165 foot by 165 foot grid is selected for the Lip Area Please provide the rationale for selection of this sized area since information present indicates radionuclide contamination higher in some outlying areas of the 903 Pad

Response
See response to Comment 12A and Sections 2 6, 2 7, and Table 2 4 of the revised SAP

Comment 12C
There are no proposed sampling locations outside the Lip Area We propose either a plan in place to proceed outside the area if contamination is found in the Lip Area or a proposal be submitted including additional sampling points outside the Lip in the first round of sampling

Response
The HPGe program is scheduled to begin in the Americium Zone (areas outside the 903 Pad and Lip Area) and HPGe measurements will determine surface soil activities in excess of Tier I soil action levels Once the area of soils is determined which exceeds this action level a subsurface soil sampling program will be designed to determine the depth of the exceedance and to calculate the volume of soil requiring action The grid will be designed following the determination of the extent of surface soil contamination (area) in excess of Tier I action levels and the SAP will be modified accordingly (see response to Comment 4B)

Comment 12D
Paragraph 2 The last sentence if the radionuclide soil sampling investigation states that the number of boreholes proposed are not statistically based Please provided what basis was used for determining the appropriate number of samples, and why one sample for data for 1976 remediation area and 4 samples for samples in 1978 remediation area will be representative

Response
An augmented explanation of sample locations and quantities has been provided in the text (Section 2 0) As stated in a previous comment response, the number and pattern of boreholes/samples is a function of project funding limitations, the number of samples for adequate confidence relative to RFCA Tier I action levels, and biasing of the grid locations to specific areas of interest

Comment 12E
Last paragraph This paragraph discusses borehole locations A reference to Figure 3-4 would be useful

Response
The text has been revised to reference Figure 3 4

Comment 13A
Page 22, Asphalt Section This section states that nine sampling locations will be selected during the subsurface investigation for asphalt sample collection for radiochemical analysis Please provide a list of what radionuclides this applies to, and describe the type of analysis which will be performed

Response

See response to comment 8B Table 3 2 presents the analytical program for surface soil and asphalt samples Asphalt samples will be analyzed by alpha spectroscopy for $Pu^{239/240}$, Am^{241}, U^{234}, U^{235}, and U^{238} Results will be compared to the applicable waste facilities WAC requirements

Comment 13B

Radiological Contamination Section Please provide further information concerning the receiving laboratory and whether it is certified by the State of Colorado

Response

The State of Colorado certification of laboratories for radiochemical analysis only applies to samples submitted for analysis under the Safe Water Act The radiochemical analyses for this SAP are for soils

Comment 14

Page 23, Second Paragraph Please provide further information concerning the FIDLER survey which may be required, i e what radionuclide will be used as a standard, what type of correlation will be made (between the fidler, the HPGe, and soil laboratory analysis), what are the "hot spot" (size, contamination levels), and how will such areas be addressed? (Same comment applies to page 26, first paragraph) Please reference appropriate SOP's where applicable

Response

FIDLER surveys will be used to verify that contamination is homogenous over HPGe measurements FOVs and to locate potential hot spots within individual FOVs that are isolated from the contiguous areas of contamination FIDLER survey results will not be correlated against HPGe measurements or surface soil results The text in Section 3 1 1 has been revised to more accurately describe the scope of the FIDLER survey A reference to ROI 4-H58-ROI-6 06, Use of Bicron FIDLER, has been incorporated

A radiological "hot spot" is defined under DOE Order 5400 5, Chapter IV, Residual Radioactive Material, Section 4 and DOE/CH-8901 A hot spot for this investigation is defined as areas exceeding the RFCA Tier I action levels for radionuclides averaged over a 100 m^2 area Tier I action levels are protective to a 85 millirem per year (mrem/yr) exposure of a hypothetical resident (DOE, 1996a)

Potential hot spots will be staked, surveyed and labeled for future evaluation Additional soil samples may be collected for isotopic analysis if it is determined that this information is necessary to determine whether a remedial action is required Information on the number, location, and total area of hot spots detected outside the contiguous area of contamination will determine what scale the areas will be remediated

Comment 15A

Page 26, Surface Soil Samples Section The first paragraph states that 10 grab samples will be taken to a depth of 2 inches over a 3 meter area, and then will be composited into a singe sample Also, the last paragraph states that a sample will be collected from each quadrant, which will then be composited into a singe sample, which will represent the area of 1,217 cubic feet Please include a justification for compositing these samples, i e provide rationale for treating the areas as homogenous and include an explanation for assuming representativeness

Response

The text in Section 3 1 1 has been modified to more accurately describe the revised surface soil sampling methodology The revised surface soil sampling program includes the collection of 6 grab samples, one grab sample collected at the center of the measurement, two grab samples collected at 1 m radius, and three grab samples collected at the 3 m radius The two grab samples collected at the 1 m radius will be composited into one sample, the three grab samples collected at the 3 m radius will also be composited into a single sample Therefore, three separate analyses will be performed at each soil sample location The results will be weighted based on the distance from the center and the weights will be summed to calculate the average activity over the FOV

Since the average activity is measured by the HPGe survey at each FOV the average soil activity is required for comparison Compositing soil samples is a cost effective and appropriate sampling method for calculating the physical average of activity over the FOV of the HPGe measurement

Comment 15B
The last paragraph states that Figure 3 2 provides the "typical surface" soil sampling scheme for HPGe correlation sampling Does this mean that all sampling points will mirror Figure 3 2? Please explain further

Response
Yes The revised surface soil sampling scheme will be utilized at all sampling locations as proposed in Section 3 1 1 4 and shown on Figure 3 2

Comment 16A
Page 28, Table 3 1 This table states that a maximum of twenty surface soil samples will be collected to correlate HPGe measurements We recommend the term "maximum" be replaced by the term "minimum"

Response
Text on Table 3 1 was revised

Comment 16B
903 Pad Asphalt Samples Section The second sentence states that nine asphalt samples will be collected from randomly selected locations over the 903 Pad, however, the fourth sentence states that locations will be randomly based on the sampling grid Please correct this discrepancy We recommend randomly based on the sampling grid

Response
Text has been revised as follows Nine asphalt samples will be collected from sample locations randomly selected from the twenty-five 903 Pad subsurface soil locations

Comment 17A
Page 29, 903 Pad Section The third sentence states that the samples will be screened for alpha and beta/gamma using a portable field instrument Please describe what type instrument will be used (include brand and model) Please elaborate on background of this instrument, how much activity does it take to register above background? Please describe the trip levels for Tier I, and include the radionuclides which will be screened

Response
Field instruments consist of the FIDLER and the ELECTRA Background FIDLER levels in surface soil are less than or equal to 2,000 cpm +/- 500 cpm Background ELECTRA levels for alpha are less than or equal to 2 cpm and beta/gamma are less than or equal to 1,000 cpm Typical background beta/gamma readings with the ELECTRA are 400 to 600 cpm Results from sample screening in the field will not be used for comparison against Tier I action levels and screening for specific radionuclides is not the purpose of the screening

Comment 17B
There is no mention of VOC characterization within the Pad on page 29, however, Table 3-3 includes 6 potential boreholes Please include this in the discussion, and provide justification for selection of the value of 3

Response
Page 29, Section 3 1 2 2, describes the radiological subsurface investigation and the VOC subsurface investigation is described in Section 3 2 Text has been revised as follows to justify the value of 3 feet for the total depth of the investigation Approximately three inches of asphalt and eight inches of artificial fill material overlie the natural soil at the 903 Pad Soils will be continuously cored to a total depth of three feet or one foot past the depth where the FIDLER indicates less than 5,000 cpm Soil samples will be collected over 6-inch intervals The depth of radiological contamination at the 903 Pad is 66 cm (26 in) based on the results of the 1980 soil decontamination project (Section 1 2 2, Existing Data Summary - Subsurface Soils)

Comment 18A
Page 31, The Lip Area Section The second paragraph describes fourteen boreholes which will be drilled However, the specific locations which will be sampled is not clear from Figure 3-4

Response
Text has been revısed to more accurately reflect the number of radıologıcal subsurface ınvestıgatıon boreholes ın the Lıp Area

Comment 18B
Agaın, background levels are referenced Please provıde further ınformatıon as to what background wıll be compared to whıch specıfic sample poınt

Response
Text has been revısed as follows Soıls wıll be contınuously cored to a total depth of two feet or one foot past the depth where the FIDLER ındıcates less than 5,000 cpm Soıl samples wıll be collected over 6-ınch ıntervals The samples wıll be screened for alpha, beta/gamma, and VOCs usıng portable field ınstruments Radıologıcal contamınatıon ıs expected from ground surface to a depth of 11 ınches based on the radıologıcal results from trench TR08 (OU2 Phase II RFI/RI)

The 5,000 cpm on the FIDLER ıs an accurate screenıng level to dıfferentıate radıologıcal contamınatıon ın soıl less than Tıer II soıl actıon levels as used on the Trenches T3/T4 and Mound Sıte Source Removal Projects

Comment 19A
Page 32, Table 3 3 It appears from the table, that you wıll be characterızıng the soıl ın the 903 Pad to a depth of 4 feet, and ın the Lıp area to a 3 foot depth Please provıde justıficatıon for choosıng these depths

Response
Sectıon 3 1 2 2, 903 Pad, dıscusses the proposed subsurface samplıng program ın thıs area Based on a 3 foot depth and sample collectıon at 6-ınch ıntervals, sıx samples wıll be collected from each borehole Twenty-five (25) boreholes are proposed ın the Lıp Area for a total of 150 samples The depth of samplıng (3 0 feet) was determıned from exıstıng soıl data from samples collected beneath the 903 Pad whıch ındıcate that radıologıcal contamınatıon may exıst to a depth of 66 cm (26 ınches) Thıs depth exceeds the thıckness of the asphalt pad (3 ın) and the depth of artıficıal fill (8 ın) and ındıcates radıologıcal contamınatıon of natural undısturbed soıls at the 903 Pad

Sectıon 3 1 2 3, Lıp Area, dıscusses the proposed subsurface samplıng program ın thıs area Based on a two foot depth and sample collectıon at 6-ınch ıntervals, four samples wıll be collected from each borehole Twenty-five (25) boreholes are proposed ın the Lıp Area for a total of 100 samples The depth of samplıng (2 0 feet) was determıned from exıstıng trench data (TR-08) from samples ın the Lıp Area whıch ındıcate that radıologıcal contamınatıon currently exısts to a depth of 11 ınches The depth of artıficıal fill ın the Lıp Area ıs approxımately 0 8 to 5 ınches (DOE, 1995a)

Comment 20.
Page 33, VOC Investıgatıon Sectıon Page 6 ın the Groundwater Sectıon, first paragraph states that "the next hıghest concentratıons of carbon tetrachlorıde ın ground water ıs found ın samples collected from Well 13191(422-4800 ppb)" Please provıde justıficatıon for not ıncludıng boreholes ın the area west of well 06691

Response
Fıgure 3 4 shows one borıng west of well 06691 The text has been revısed to more clearly descrıbe the methodology to be used for the VOC ınvestıgatıon The proposed radıal geometry placement of boreholes for the VOC Investıgatıon uses well 06691 as the center wıth one borıng placed 20 feet to the north, south, west, and east Addıtıonal borıngs wıll be located radıally based on the hıghest field readıngs or analytıcal results

Comment 21
Page 34 Fıgure 3-4, Please provıde further detaıls on thıs figure ın relatıon to the 903 Pad, Lıp and Amerıcıum Zone

Response
Fıgure 3 4 has been revısed to ıncludes labels for the 903 Pad and 903 Lıp Area

Comment 22A

Page 35, VOC Subsurface Soıl Characterızatıon Fıeld Program You have proposed a depth of "one or two feet below top of bedrock" for borehole depth We belıeve that dependıng upon the nature of the bedrock, boreholes could proceed further Please ınclude a contıngency statement ın thıs portıon for thıs potentıal as thıs would allow further characterızatıon of not only the DNAPL's but also the bedrock materıal as well

Response

Text has been revısed as follows to allow vertıcal definıtıon of the extent of VOC contamınatıon Boreholes wıll be advanced from the ground or asphalt surface to a depth of one or two feet below the top of bedrock or one to two feet below the vertıcal extent of VOC contamınatıon (based on field ınstruments)

Investıgatıon of potentıal DNAPL wıll be evaluated as follows If DNAPL ıs suspected, an attempt to collect a lıquıd sample from the core barrel wıll be made and the borehole wıll proceed no more than approxımately two feet ınto bedrock

Comment 22B

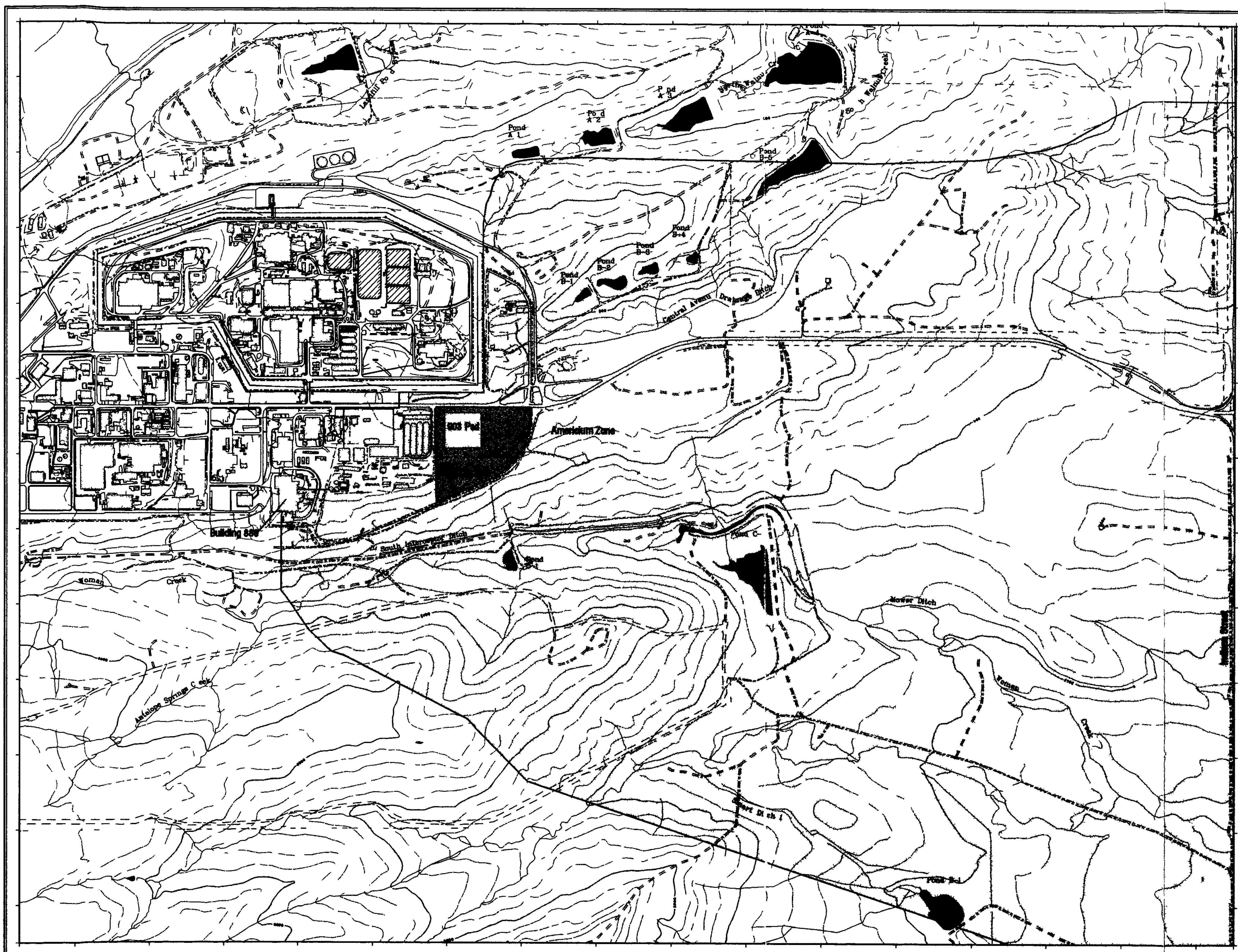
Table 3 5, Provıde ratıonale for no characterızatıon beıng conducted ın the Amerıcıum zone, ı e why do you belıeve there wıll be no DNAPL's or VOC's ın thıs area, although radıonuclıde contamınatıon exısts?

Response

The text has been revısed wıth a more detaıled dıscussıon of the sıte conceptual model ın Sectıon 1 3 An ınsert from that text follows The contamınants present ın the surface and subsurface soıl are prımarıly a result of drum storage ın the 903 Pad and Lıp areas Drums contaınıng plutonıum and uranıum-contamınated volatıle organıc compounds leaked The radıologıcal components were retaıned ın the upper one foot of the surface soıl due to the lımıted mobılıty of these components However, the lıquıds from the drums moved downward towards the bedrock surface, possıbly carryıng the radıonuclıdes ınto the subsurface along preferentıal pathways such as rodent holes, desıccatıon cracks, and/or along decayed roots Hıgh wınds and heavy raıns spread the surficıal radıologıcal contamınatıon outward from the Pad area, deposıtıng ıt ın the Lıp Area and Amerıcıum Zone Thus, the Amerıcıum Zone ıs not a source area for VOC groundwater contamınatıon

Sampling and Analysis Plan for the Site Characterization of the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Study Area Location Map
Figure 1 1



EXPLANATION

- 903 Lip Area
- Study Area
- 903 Pad

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

Scale = 1 11880
1 inch represents approximately 991 feet

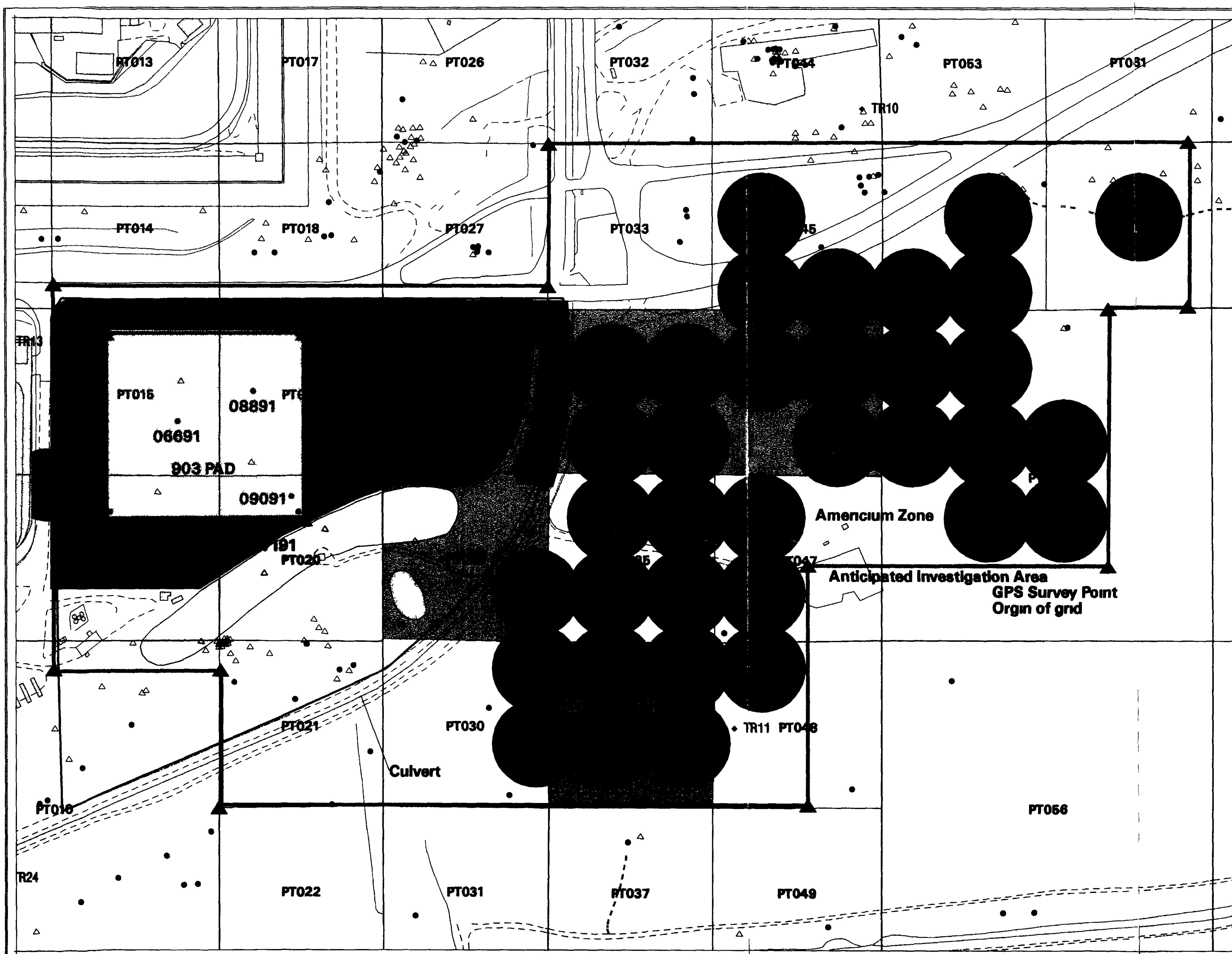
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U S Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
RMRS Rocky Mountain Remediation Services, L.L.C.

MAP ID: 98-0014

December 15, 1997



Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Investigation Area Location Map

Figure 1.2

Explanation

- HPGe 150 foot FOV Circles (above 10pCi/g Am 241)
- Plots above Tier I Action Levels
- Proposed GPS Survey Point
- Groundwater Well Locations
- Borehole Locations
- Soil profile Sampling Sites
- 1976 Soil Removal Area (approx)
- 1978 Soil Removal Area (approx)
- 1970 Soil Fill Area

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams ditches or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads

Scale 1:2160
1 inch represents 180 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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RMRS
Rocky Mountain Remediation Services, L.L.C.

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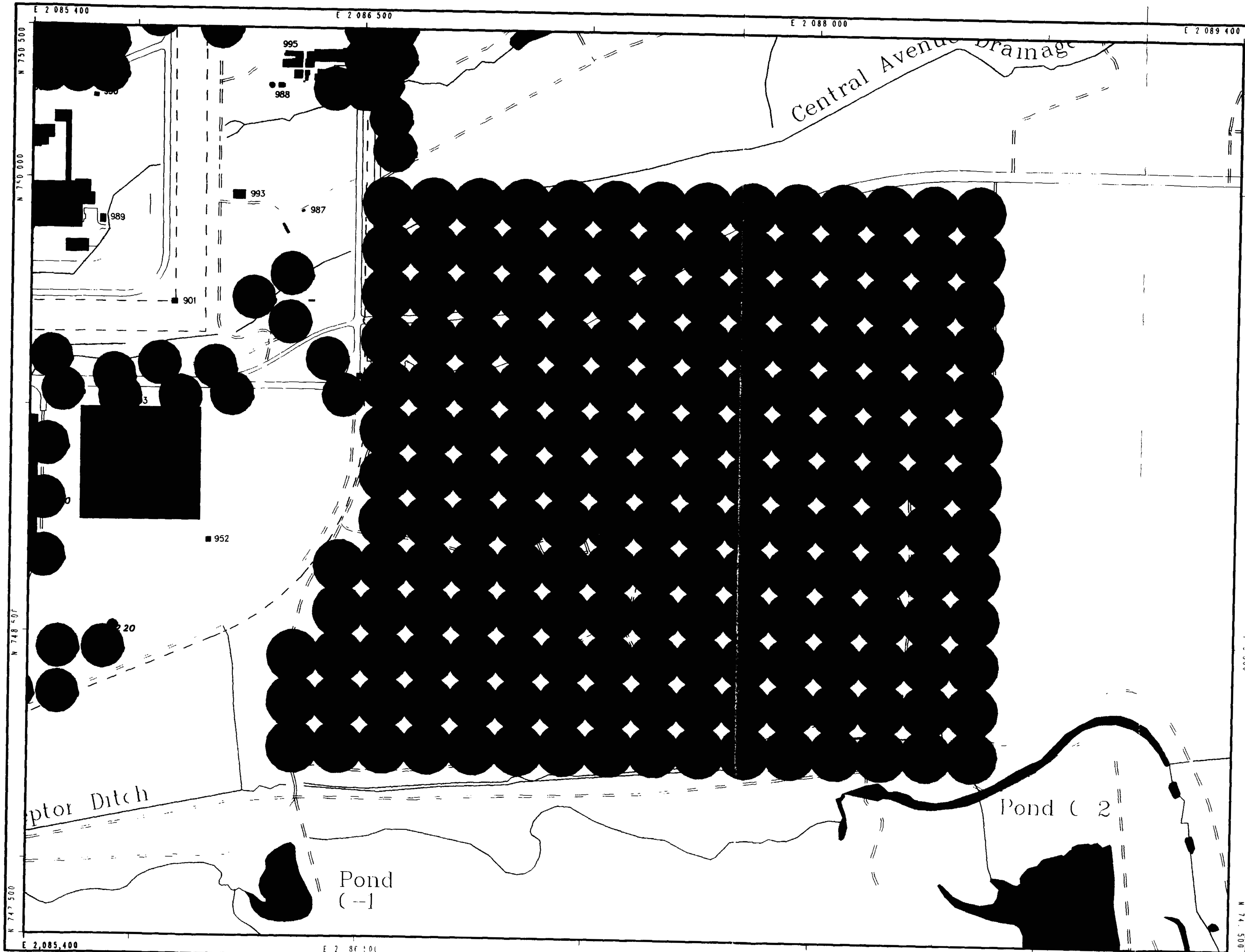


Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area, 903 Lip Area and Americium Zone

1994 HPGe Survey Data for Am 241 in Investigation Area

Figure 1.3

HPGe Data Rang e– pCi/g for a Field of View of 150 feet (DOE 1995a)

- 00 01
- 01 1
- 1 10
- 10 100
- 100 1000
- 1000 10000

Standard Map Feat res–

- Building d other structure
- Lakes d pond
- Streams, ditches, the dra nage feature
- Fence
- Rocky Flats boundary
- Paved road
- Dirt road

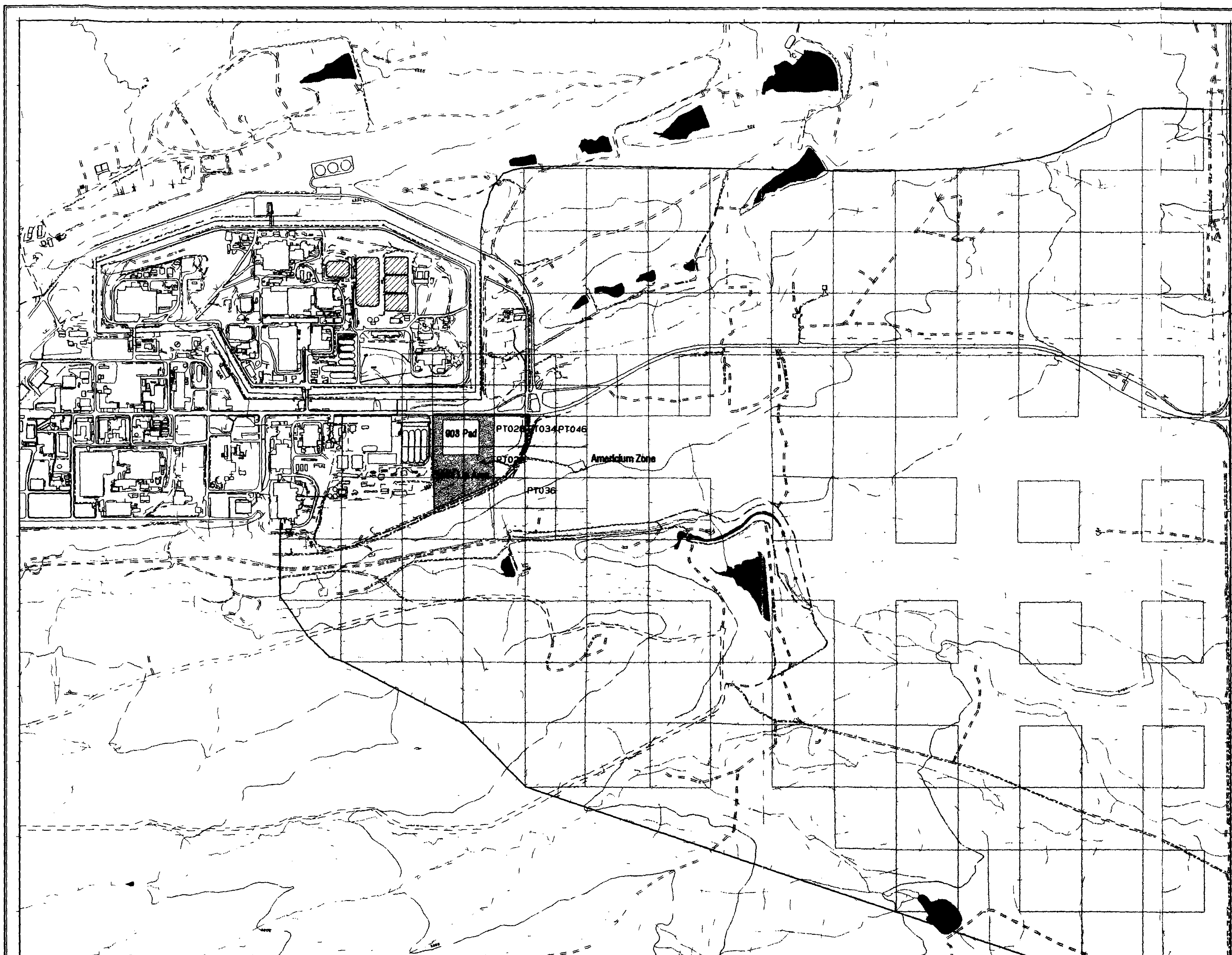
U S Departm t of E ergy
Ro ky Flats En I onm nt IT hnology Site

Prepared by

RMRS Rocky Mountain Remediation Services L.L.C
Geographic Information Systems Group
Rocky Flats En ronmental ech Sit
Box 464
olden CO 80402-0464

MAP ID: Invest-area

December 8, 1997



Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area, 903 Lip Area and Americium Zone

OU2 Phase II RFI/RI Surface Soil Sampling Plots Study Area

Figure 1.4

EXPLANATION

- CDH & RF Surface Soil Sampling Plot (DOE, 1995a)
- Study Area
- 903 Lip Are
- Sampling Plot Exceeding Tier I Soil Actions Level Radoinuclides (DOE, 1995a)

Standard Map Features

- Buildings and other structure
- Solar evaporation pond
- Lake and ponds
- Stream ditche or other drainage feat res
- Fence and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt road

Scale 1 11890
1 inch epresent appr ximately 991 feet

50 0 500 1000ft

Stat Plane Coordi at Pr jection
Colorado Central Zone
Dat m NAD27

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Prepared by
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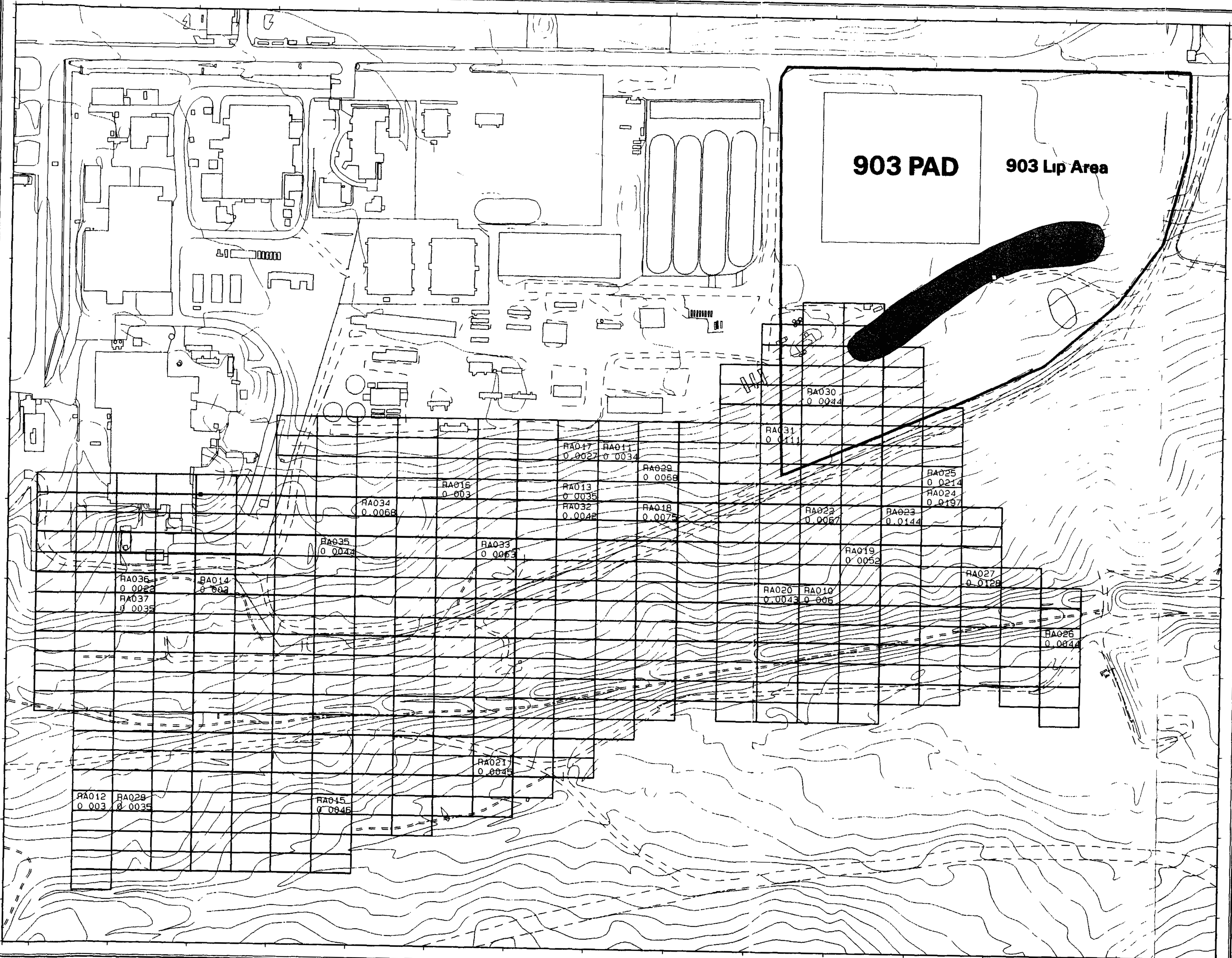
MAP ID: 98-0014

December 15, 1997



Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area, 903 Lip Area and Americium Zone

OU1 Phase III RFI/RI Surface Soil Sampling Locations, Study Area

Figure 1.5

EXPLANATION

- 5 Foot contours
- 903 Pad Lip Area
- 1978 Soil Removal Area (approx)
- 1978 Soil Removal Area (app ox)
- Plot Number / Sum of Ratios Radionuclides

Sta dard Map Features

- Building & other structure
- Fences d other barriers
- Paved road
- Dirt road

50 0 100 200ft

Stat Plane Coordinate Projection
Colorado Central Zon
Datum NAD27

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MAP ID 97-0039

December 15, 1997

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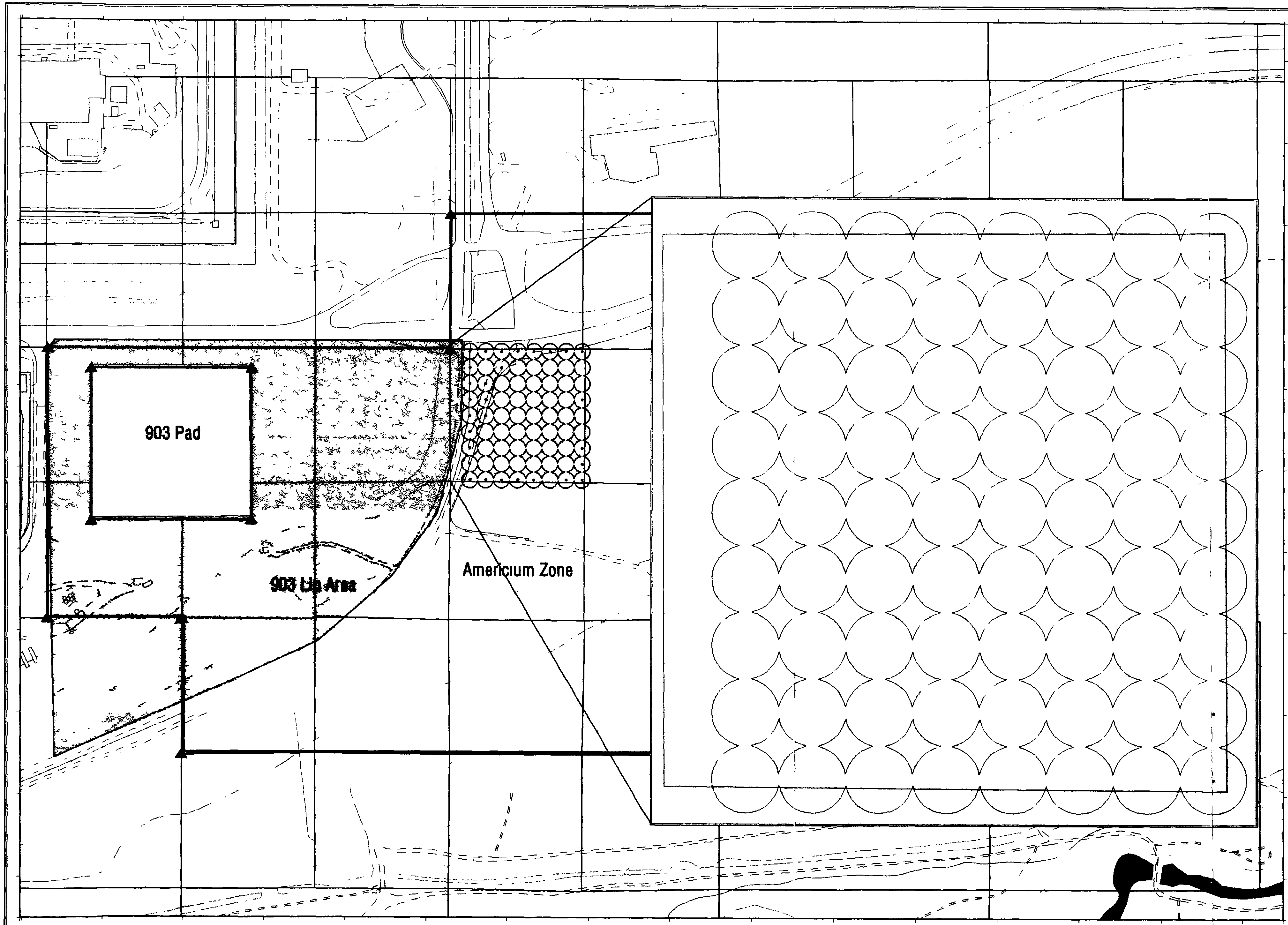

Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Typical HPGe Survey Grid

Figure 3 1

EXPLANATION

Surf Soil Sampli g Plot

HPGe S rvey Locatio

HPGe Mea m nt Fi ld f View

903 Lip A

Standard Map Features

Building d oth structur

Lake d po d

St ms, ditche the d i ge feat

Fenc d oth b ri rs

Co to (20-Foot)

Paved d

Dirt ro d

Scale 1 2840
1 inch ep sent approximat ly 237 feet

0 0 100 200 ft

Stat Plane Coordinat Projectio
Colorado Central Zone
Dat m NAD27

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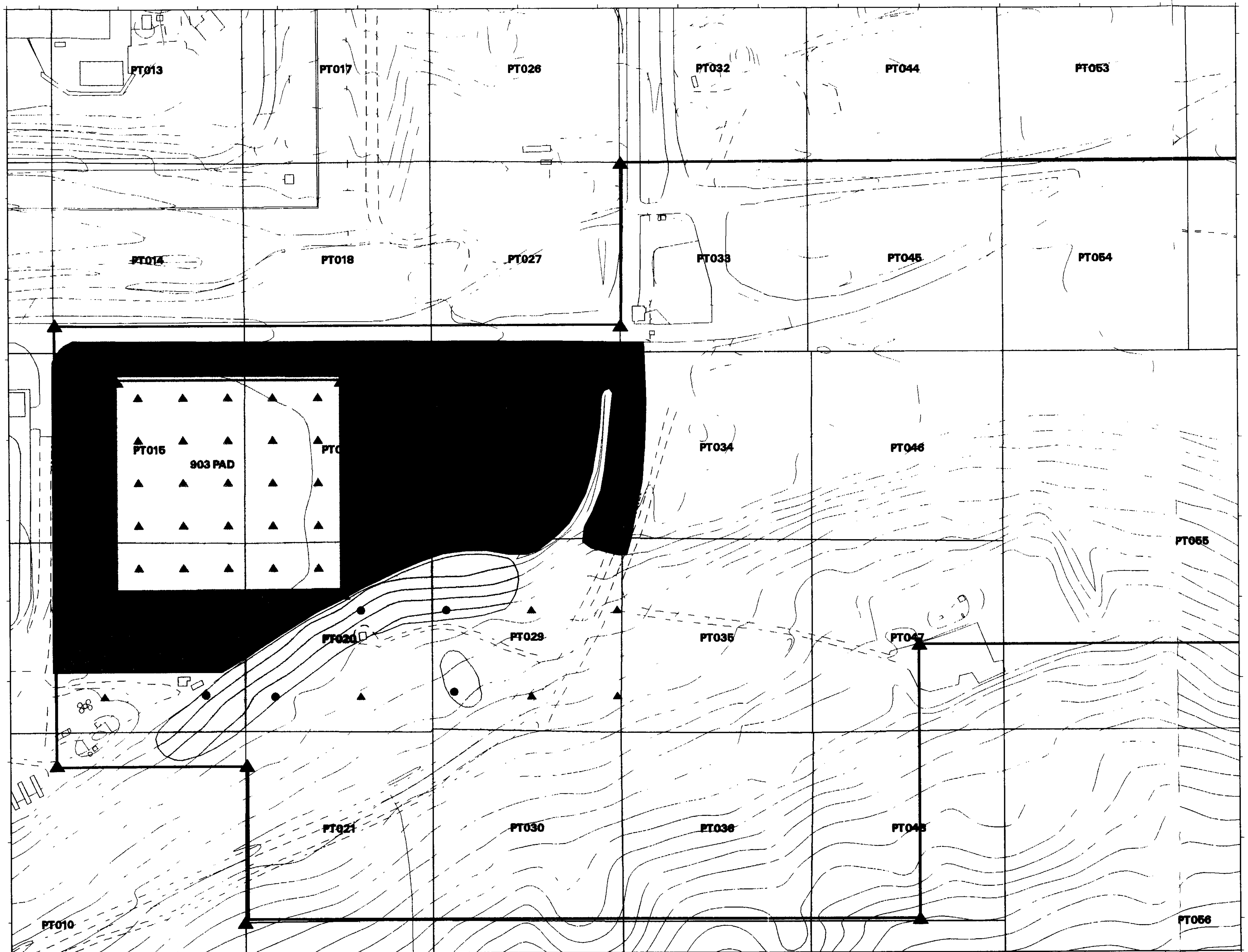
Rocky Flats Environmental Technology Site

Prepared by

RMRS Rocky Mountain Remediation Services, L.L.C.

MAP ID 98-0014

November 17, 1997



Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Radiological Subsurface Sampling Locations 903 Lip Area

Figure 3 3

EXPLANATION

5 ft elevation contour

Investigation Area

1976 Soil Removal Area (approx)

1978 Soil Removal Area (approx)

1970 Soil Fill Area

Optional Borehole Locations to close to grid in 903 Pad Lip Area Boreholes

Soil Borings

903 Pad Boreholes

Standard Map Features

Buildings

Lakes and ponds

Streams ditches or other drainage features

Fences

Paved roads

Dirt roads

0 100 200ft

Stat Plane Coordi at Pr jecti
Colorado Central Zone
Datum NAD27

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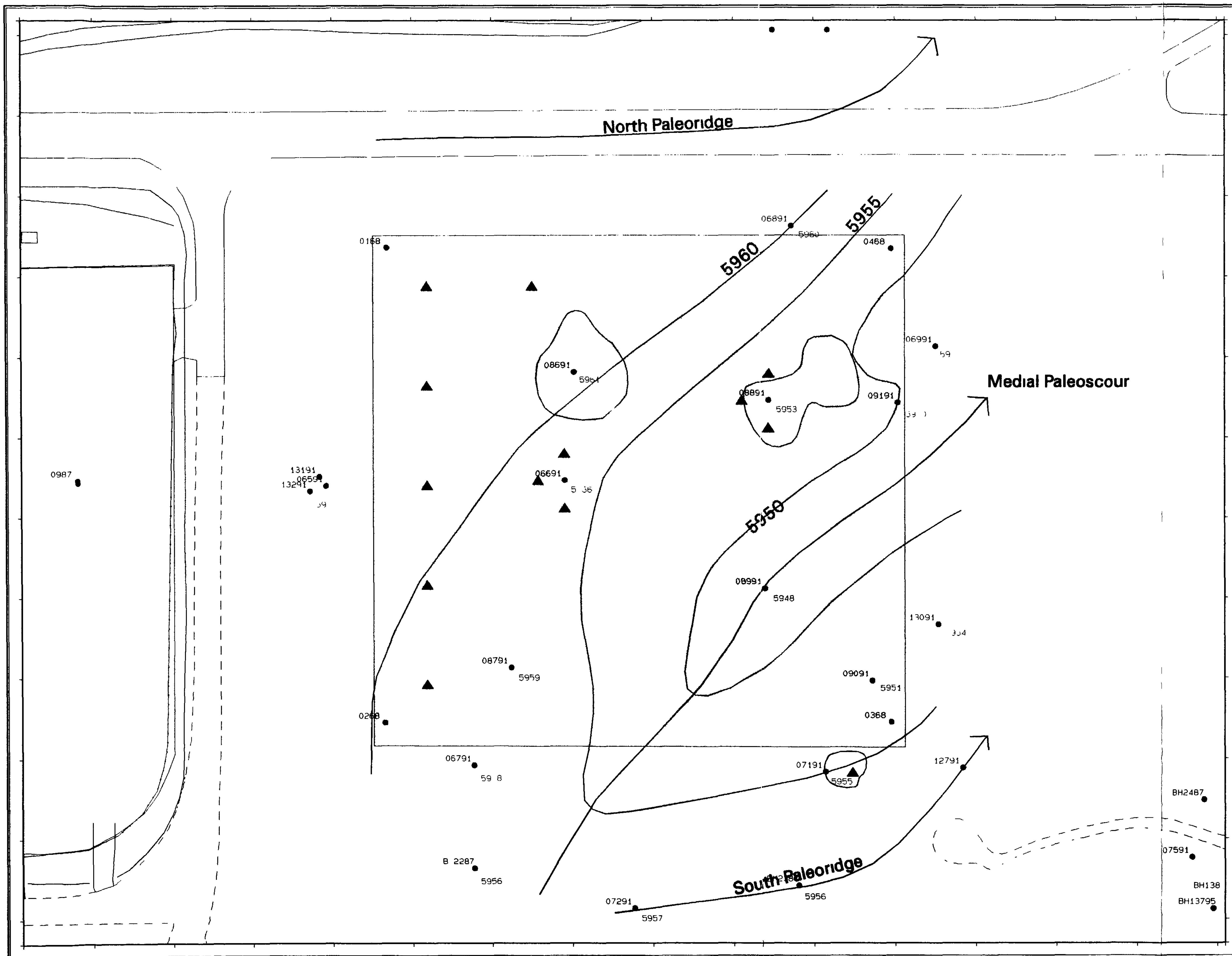
Geographic Information Systems Group

MAP ID 97-0149

December 15, 1997



Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area, 903 Lip Area and Americium Zone

VOC Investigation Borehole Location Map

Figure 3 4

EXPLANATION

- Pr posed Boreholes
- G ndwat Monitoring Well Location Code-left Top f Bedrock Elev-right
- Borehol Location Code-left Top of Bedrock Elev-right
- Top of Bedrock Elevati Contour
- Soil Gas Concent atio > 100 ppm
- Paleot pog hi Trends
- Individual Haz rdou Substance Sit (IHSS 112)

Standard Map Features

- Lakes and po ds
- St eams, ditches, r ther d inage features
- Fences and other barriers
- Paved oads
- Dirt roads

Scale = 1 840
1 i ch represent 70 feet

0 50 100ft

Stat Plane Coordinate Projection
Colorado Central Zone
Datum NAD27

U S Department of Energy
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